Keeping radiotherapy safe and effective

Q&A with leading dosimetry expert

By Nathalie Mikhailova

Radiation is key to the fight against cancer, helping to save countless lives worldwide. But too little radiation can mean ineffective treatment, while too much can cause harm. That's where dosimetry comes in.

Dosimetry is the science of measuring, calculating and assessing absorbed doses of radiation. It is used by medical physicists to ensure that machines delivering radiation to patients are accurate and properly calibrated. This is critical to patient safety.

So, what goes into dosimetry? How do we ensure it is reliable? To find out more, we sat down with David Followill, Director of Imaging and Radiation Oncology Core (IROC) at the Houston Quality Assurance Center at the University of Texas MD Anderson Cancer Center, USA. IROC Houston is home to the largest dosimetry quality assurance centre in the world, which has assisted 2200 radiotherapy centres in 58 countries. As Director of IROC Houston and with over 20 years of experience in dosimetry, Followill has devoted his career to ensuring the accurate, consistent and safe delivery of radiotherapy to cancer patients.

Q: Dosimetry is used to keep radiotherapy safe and effective, but how do we ensure dosimetry itself is reliable?

A: Humans make mistakes. These can be either an individual mistake with one X-ray or electron beam, or a systemic mistake that affects all the beams involved in radiation delivery. These kinds of mistakes can go unnoticed unless someone is double-checking the doses. The dosimetry audits we perform at IROC Houston, and those done by the IAEA, as well as other institutions around the world, are vital to ensuring accurate and consistent doses.

Audits are independent peer reviews of a clinic's radiotherapy treatments. Clinics are provided with passive dosimeters (devices designed to measure an absorbed dose of radiation), which the clinic irradiates and sends back to the auditing programme to be evaluated. The audit results confirm if clinics are measuring doses correctly and help them identify and correct any potential mistakes. Getting others to take a second look means they can be confident in the accuracy of their dosimetry measurements.

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—David Followill, Director of Imaging and Radiation Oncology Core (IROC), Houston Quality Assurance Center, University of Texas

Q: What do you think is needed to build and maintain a sound dosimetry programme at an institution?

A: Any clinic's dosimetry programme needs to start with the robust training of medical physicists. Medical physicists need to not only know how to use the dosimetry equipment but to truly understand how it works to be able to judge if readings

are correct or not. They need to always be critical, constantly reviewing their information and be willing to admit if they have made a mistake.

Every clinic also needs reliable equipment that is continually calibrated and subject to quality assurance reviews, so that it produces accurate and consistent readings. With the help of additional educational courses and peer review papers, health professionals can continue to understand and overcome resource limitations. Only in these ways can clinics be sure that the patients are getting as accurate a dose as possible.

Q: How does international cooperation, such as between the IAEA and IROC Houston, improve dosimetry worldwide?

A: IROC Houston and the IAEA have been collaborating since the early 1980s and are probably the two largest entities that perform audits. Collectively, we monitor a lot of institutions worldwide, develop programmes for local hospitals, and exchange techniques and knowledge on how to best perform audits.

We also compare dosimetry measurements; we both irradiate the same dosimeters from each other's programmes to verify that we're getting the same dose measurements. We not only learn from each other, but also from the results we receive from local hospitals.

These exchanges give us confidence in our system and in the fact that we are putting out correct, precise values. They also allow us to uncover issues that may not have been discovered by individual clinics. In this way, we improve our ability to perform audits, understand why people make mistakes and improve the efficiency of our work. Since the number of radiation therapy machines worldwide is increasing, we're always looking for ways to improve our efficiency and workflow process.

Q: How is dosimetry advancing? What do you think the future holds for the field?

A: Advances are continually being made, but one increasingly common development is in devices that give us the total treatment delivery picture. This means we can use different dose measurement equipment that measures part of or the whole treatment immediately before a patient is treated. This end-to-end quality assurance dosimetry check goes through the whole process, from imaging to delivery of radiotherapy. This way we can, on the spot, double check the actual dose that is going to be delivered by the system before exposing a patient.

Nonetheless, you always have to make sure that the basic components to any radiation therapy programme are done correctly. We still rely very heavily on the simple water phantom (a physical model used for calibrations), ion chamber and electrometer system to take measurements. And in terms of audits, we're still doing the basics because we need something that's portable to transport between clinics. This type of dosimetry has been around for decades. It is the standard and is used widely.

A medical physicist sets up equipment during an on-site audit at a proton therapy center.

(Photo: J. Montgomery/MD Anderson Cancer Center)