Dr. Caroline Chung completed her undergraduate studies in biochemistry – molecular biology and genetics at the University of British Columbia (UBC) in Vancouver, Canada, in 1999 and continued at UBC to complete her medical degree and Radiation Oncology residency in 2008. She then completed a two year Research Fellowship in Radiation Oncology at the Princess Margaret Cancer Centre in Toronto, Canada, concurrently with a thesis M.Sc. at the University of Toronto's Institute of Medical Sciences and Royal College of Physicians and Surgeons of Canada Clinician Investigator Program at the University of British Columbia in 2011. Dr. Chung was then recruited to practice as a Clinician-Scientist in the Radiation Medicine Program of the Princess Margaret where she held the rank of Assistant Professor in the Department of Radiation Oncology at the University of Toronto and she was co-lead of the Brain Metastasis Clinic and Program at Princess Margaret Cancer Centre. In 2016, she was recruited to the MD Anderson Cancer Center in Houston, Texas, USA, to be the Director of the Advanced Imaging Strategic Initiative within the Division of Radiation Oncology with cross-appointment to Division of Diagnostic Imaging. She is currently an Associate Professor and the Director of Imaging Technology and Innovation within the Division of Radiation Oncology. In addition to running her own computational laboratory in oncological imaging research, as Director of Magnetic Resonance (MR) Research she leads collaborative research studies of MR-guided radiotherapy including the use of MR for target delineation, real-time MR image guidance of radiation delivery and imaging biomarkers of response.

Her major research focus is in the utilization of advanced imaging to measure and predict response and toxicity to treatment. In her career, she has published over 90 articles in peer-reviewed journals and has been highly successful in securing peer-reviewed funding for both clinical trials and translational research. Her efforts extend from preclinical investigations of imaging response biomarkers utilizing multi-parametric MR imaging for conformal radiotherapy and anti-angiogenic therapy thru to translational research of imaging biomarkers in clinical trials for patients treated with SRS with and without anti-angiogenic therapy for brain metastases. She is a principal investigator in an NCI-supported randomized trial of bevacizumab vs. corticosteroids for brain radionecrosis that incorporated advanced MR for both trial eligibility and early response assessment. More recently, she has established collaborative projects with NASA to investigate imaging and fluid-based biomarkers of radiation injury to the heart and brain. Dr. Chung has also made significant contributions to the field through her work on standardization in medical imaging. She is co-chair of the Dynamic Contrast Enhanced-MRI Committee for the Radiological Society of North America Quantitative Imaging Biomarker Alliance, a member of the Jumpstarting Brain Tumor Drug Development Coalition's Imaging Standardization Steering Committee, Co-Chair of the Neuro-imaging Subcommittee in the Neuro-Oncology Committee of the Alliance for Clinical Trials in Oncology and has taken leadership in the development of quantitative imaging initiatives both in Toronto and Houston. She is active in the Radiation Oncology and Diagnostic Radiology communities in her dedicated efforts to advance the role of quantitative imaging and technology in cancer care, to develop gender diversity in leadership, and for her passion in supporting and supervising young talent.

Advancing MR to Fulfil its Role in Oncology: Time to Finish the Pivot from Adjunctive to Essential

Dear readers and colleagues,

Cancer care has been transformed by the development of three-dimensional imaging techniques since their emergence into clinical care in the 1970s and 80s. Early computed tomography (CT) and magnetic resonance (MR) imaging systems provided soft-tissue visualization of both tumor and normal anatomy to provide oncologists with insights of the distribution and overall burden of disease that have advanced our ability to stage and prognosticate cancer since the first American Joint Committee Manual for Staging of Cancer in 1977 [1]. In those early days, imaging studies provided insights that were largely treated as qualitative, adjunctive information, which when combined with the clinical exam, would enhance clinical decision-making.

The role of imaging data in oncological clinical care has evolved dramatically in recent years where imaging has transitioned from its adjunctive role to become a clinician-directed measurement tool for prognostication and response assessment, as well as a tool for directly guiding intervention. MR imaging, in particular, has advanced at an astounding pace with improvements in image quality and new capabilities to interrogate tissue microstructure, physiology and metabolism, generating more mechanism-oriented measures that could be integrated into clinical decision-making for precision medicine approaches. However, while the imaging systems have advanced, the persistent qualitative nature in the use and interpretation of medical imaging has to-date prohibited utilizing the full potential of the rich multiparametric and multimodal imaging data in the guidance of cancer care.

Complementary to the advances in imaging technology itself, the rapidly growing computing power and prevalence of artificial intelligence (AI) in the world around us has certainly introduced new opportunities

Work in progress: the application is currently under development and is not for sale in the U.S. and in other countries. Its future availability cannot be ensured.

and challenges in medicine and particularly in the field of radiology. There are promising strides in utilizing AI to improve image quality, accelerate image acquisition and image reconstruction, as well as assist with image interpretation. One question that has arisen amidst the enthusiasm for AI applications in medical imaging is whether the requirements of imaging data are different in the adjunctive paradigm used by humans than numerical algorithms and whether the qualitative approach to imaging information in current practice will suffice in the era of human-machine hybrid medical care.

In order to fully address these evolving requirements and applications of imaging data, the community needs to make a conscious pivot from treating MR imaging data as a qualitative assessment tool when in actuality clinicians and the evolving technology around us are pushing its use as a quantitative measurement tool. This pivot requires critical steps that address the consistency and quality of imaging data at the time of imaging acquisition, post-processing and analysis, as well as changes in human behavior.

A dedicated effort is being led by groups including the Radiological Society of North America Quantitative Imaging Biomarker Alliance, which has broadly engaged institutions globally and partnered with industry to facilitate this transition of imaging from pictures to quantitative measurement. Through growing knowledge dissemination, clinical trial investigators have come to appreciate the impact of variable image acquisition on robust response assessment. Recently, members of collaborative clinical trial groups with the endorsement of the U.S. Food and Drug Administration (FDA) and National Cancer Institution (NCI) have established standardized MR acquisition protocols for primary and secondary brain tumors [2–4]. While establishing consensus for standardized image acquisition protocols are a first step, clinical adoption of these standardized protocols remains a challenge and along with this, the quality assessment metrics of MR imaging data need to be established for truly impactful implementation of quantitative MR imaging. Beyond the image acquisition, quantitative image interpretation also relies on standardized and transparent post-processing and analysis of imaging data with a quantitative approach, as fostered by groups such as the Quantitative Imaging Network [5–7]. Ideally, these academic collaborative efforts will include close industry engagement that will lead to the development of tools that enable broad deployment of quantitative MR implementation across varying clinical environments from large academic centers to community-based settings.

As highlighted in this edition of MReadings, the clinical research community is working aggressively to make the pivot and learn how to utilize the full and immense power of MR to quantitatively characterize and target tumors and tissues to improve radiotherapy delivery, as well as assess and adapt to early response to treatment. This transition will not only maximize the benefit of the ever-improving MR information to clinical decision-making, it will release the full power of multiparametric MR to characterize tissues for its use in biological targeting of tumor and biologically relevant radiation dosing of tumor subregions while limiting radiation-associated toxicity to the surrounding normal tissues – realizing personalized MR-guided radiotherapy.

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