Published in final edited form as:

JAMA Oncol. 2017 April 01; 3(4): 565. doi:10.1001/jamaoncol.2016.4849.

In reply to Dr. Callahan and Dr. Strauss's comments on our Letter to the Editor

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To the Editor

We greatly appreciate Drs. Callahan and Strauss's interest in our recent publication [1] and their constructive comments regarding the critical role of medical imaging in the clinic.

We agree that a lot of efforts have been put into clinical practice by the industry as well as the academia to guide medical imaging decision-making and to improve patient safety, such as a computerized radiology order entry and decision support system [2], Appropriate Use Criteria guidelines, NEMA XR-29 standards, MITA Smart Dose protocols, and Choosing Wisely campaign. There is no argument that medical imaging such as computed tomography (CT) has saved numerous lives by providing the clinicians with real-time accurate diagnosis and visualization.

We certainly agree that a 'one-protocol-fits-all' approach is not *generally* applied worldwide. We also agree that there continues to be important development in personalizing imaging protocols for individual patient, especially in leading medical institutions. Indeed, in our letter, we stated that a 'one-protocol-fits-all' practice is *often* applied in the clinic worldwide, implying that there is a disparity in clinical practice with respect to usage of personalized imaging protocols and appropriateness criteria. For example, in a 2010 analysis of appropriateness of 459 outpatient CT and MRI examinations referred from primary care clinics, Lehnert and Bree identified that 118 (26%) examinations did not meet the American College of Radiology (ACR) Appropriateness Criteria and subsequently yielded negative results [3]. In another study by Bautista *et al.*, only 3 out of 126 physicians (2.4%) used the ACR Appropriateness Criteria when ordering imaging studies for their patients, much fewer than the 35 physicians (27.8%) who used Google as one of their top three resources [4]. One of the main reasons for low utilization of the ACR Appropriateness Criteria is a lack of awareness about the existence of these criteria [4].

While it is debatable whether the Linear No-Threshold (LNT) model is accurate or not in estimating the cancer risk from low-dose radiation exposure, two recent cohort studies carried out in Australia, France, UK and USA have once again demonstrated the strong correlation between ionizing radiation and cancer risk in both children and radiation-

monitored workers, who have received elevated radiation doses from CT scans during their childhood or adolescence [5], or have been exposed with higher ionizing radiation than the general public in their work [6]. Our own institutional study of 4,832 cancer patients who underwent image-guided radiation therapy (IGRT) indicated that due to non-personalized settings and over-usage of image guidance procedures in the clinic, 5% of patients received doses in excess of 100 cGy from the radiological procedures used in IGRT. In comparison, only less than 3% of the total 94,000 atomic bomb survivors in World War II received a dose of 100 cGy or more.

As our colleagues correctly point out, today we are better informed than ever to make the right decision for our patients. However, studies show that there is still a long way to go to ensure that all physicians make the right decision for their patients.

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