

Radiogenomics: The Promise of Personalized Treatment in Radiation Oncology?

Carol Proud, MSN, CRNP, ANP-BC, AOCNP®



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Significant variability exists in normal tissue reactions in patients with cancer receiving radiotherapy, with a subpopulation exhibiting increased toxicity to ionizing radiation. Genomic studies have proposed that single nucleotide polymorphisms in DNA repair genes, cytokines, and reactive oxygen species may play a role in clinical radiosensitivity. Additional research examining the association between genetic variants and radiation-induced inflammation and fibrosis may spur the development of targeted therapy in radiation oncology, which could increase cure rates and limit toxicity. As more people become long-term cancer survivors, oncology nurses must aggressively assess and manage late treatment side effects to optimize patient functioning and quality of life. The purpose of the current article is to describe the effect of ionizing radiation on normal and irradiated tissue, discuss genetic mutations that are proposed to influence radiosensitivity, and identify future areas of research on the association between genetics and radiation toxicity.

Carol Proud, MSN, CRNP, ANP-BC, AOCNP®, is an oncology nurse practitioner in the Department of Radiation Oncology at the University of Pennsylvania Medical Center in Philadelphia. The author takes full responsibility for the content of the article. The author did not receive honoraria for this work. The content of this article has been reviewed by independent peer reviewers to ensure that it is balanced, objective, and free from commercial bias. No financial relationships relevant to the content of this article have been disclosed by the author, planners, independent peer reviewers, or editorial staff. Proud can be reached at carol.proud@uphs.upenn.edu, with copy to editor at CJONEditor@ons.org. (Submitted April 2013. Revision submitted July 2013. Accepted for publication July 15, 2013.)

Key words: genetics; genomics; late effects of cancer treatment; radiation therapy

Digital Object Identifier: 10.1188/14.CJON.185-189

The field of radiation oncology has undergone many advances. New technology has spurred the development of intensity-modulated and image-guided radiation therapy, proton therapy, high-dose rate brachytherapy, and stereotactic radiosurgery techniques (e.g., gamma knife, CyberKnife®). About 60% of all patients with cancer receive radiation therapy for curative intent, tumor control, or palliation of symptoms (Halperin, Wazer, Perez, & Brady, 2013). The goal of treatment delivery is to provide a precise dose of radiation to the tumor and limit damage to surrounding normal tissue. Although most patients tolerate treatment with minimal side effects, a subset of individuals develop severe toxicities as sequelae of radiation therapy. Molecular profiling of tumors has begun to revolutionize the systemic treatment of cancer, but radiation oncology lags in identifying genetic factors that may confer individual susceptibility to radiation injury and toxicity.

Radiosensitivity is influenced by the effects of ionizing radiation on intracellular DNA, leading to cellular damage or

death via double-strand breaks. Radiation also triggers the release of multiple cytokines, which are regulatory proteins that exert their intracellular effects via receptors on immunomodulatory cells (Martin, Lefaix, & Delanian, 2000). About 5%–10% of patients who receive radiation therapy exhibit a heightened sensitivity to conventional radiation doses (Gatti, 2001; Ozsahin et al., 2005; Popanda, Marquardt, Chang-Claude, & Schmezer, 2009). To limit toxicity, standardized dosing regimens have been developed and extensively researched for safety and efficacy. Advances in genetic research would enable radiation oncologists to design personalized therapy and optimize treatment plans for each patient, which would increase efficacy and minimize acute and late side effects (Ghazali, Shaw, Rogers, & Risk, 2012; Henríquez-Hernández et al., 2012). The current article describes the effect of ionizing radiation on normal and irradiated tissue, discusses genetic mutations that are proposed to influence radiosensitivity, and identifies future areas of research on the association between genetics and radiation toxicity.