Significant variability exists in normal tissue reactions in patients with cancer receiving radiation therapy, 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.

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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.