Cancer Genetics and Genomics: Essentials for Oncology Nurses

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Cancer genetics and genomics are rapidly evolving, with new discoveries emerging in genetic mutations, variants, genomic sequencing, risk-reduction methods, and targeted therapies. To educate patients and families, state-of-the-art care requires nurses to understand terminology, scientific and technological advances, and pharmacogenomics. Clinical application of cancer genetics and genomics involves working in interdisciplinary teams to properly identify patient risk through assessing family history, facilitating genetic testing and counseling services, applying risk-reduction methods, and administering and monitoring targeted therapies.

Oncology nurses need to understand the essentials of genetics and genomics as a foundation for clinical practice. Science and technology continue to advance in genetic molecular markers, risk-reduction methods, and targeted therapies for cancer (Calzone, Jenkins, Bakos, et al., 2013; Oncology Nursing Society [ONS], 2012; Santos et al., 2013). In the fast-paced environment of oncology nursing, core competencies include risk assessment, facilitating access to genetic counseling or testing services, and knowledge about new cancer therapies and preventive care (Calzone et al., 2010; Calzone, Jenkins, Nikol, et al., 2013). Genomics also requires that oncology nurses provide tailored treatments to patients (Calzone, Jenkins, Bakos, et al., 2013). Greco, Tinley, and Seibert (2012) and the American Nurses Association (2009) provide resources for oncology nurses to learn the essentials of genetic and genomic nursing. The National Institutes of Health’s Genetics Home Reference (2014) and National Human Genome Research Institute (2012) also provide resources regarding terminology, training, education, and risk reduction. Those resources provide a foundation on (a) emerging basic science about genetic mutations and markers, as well as principles of application to therapies; (b) knowledge and skills about genetic risk assessment tools and prevention (e.g., family history, clinical algorithms); (c) information and technology; (d) follow-up preventive care needs; and (e) ethical, legal, and social implications.

Preparation for Nurses

Clinical oncology nursing includes an understanding of cancer genetics (i.e., single gene disorders) and cancer genomics (i.e., identification of multiple genes, DNA sequences, and proteins, as well as their interaction with one another) (ONS, 2012). Competency-based training for advanced practice nurses involves comprehensive risk assessment, facilitation of genetic testing and counseling, and follow-up patient care (ONS, 2012).

Clinical cancer care now includes epigenomics (i.e., epigenetic modifications of genetic material) related to inherited forms of cancer, as well as epigenomic testing, preventive care, and treatment responses (Calzone, Jenkins, Nicol, et al., 2013; ONS, 2012). Nurses also should be aware of early detection and preventive care of inherited cancers (e.g., breast, ovarian, colorectal, kidney, pancreatic, prostate, leukemia) (Robson, Storm, Weitzel, Wollins, & Offit, 2010) (see Table 1). Knowledge of pharmacogenomics and targeted therapies also are standard. Pharmacogenomics (i.e., drug therapies for identified mutations) are based on an understanding of whole-genome sequencing, leading to targeting receptors (e.g., BRAF, KRAS, MTOR, tyrosine kinase inhibitors). Targeted therapies include monoclonal antibodies or small molecular agents that penetrate the cell membrane with protein inhibitory properties (Genetics Home Reference, 2014). Nurses should be familiar with testing methods used to identify candidate genes and single nucleotide polymorphisms, which may lead to future genetic biomarkers (Conley et al., 2013).

In addition, knowledge of genetics and molecular biology (e.g., DNA structure and function, carcinogen effects on DNA and cell function, genetic mutations, genetic variants, polymorphism practices) is essential because they can affect risk-reduction strategies and underscore healthy lifestyles (ONS, 2012). Molecularly targeted therapies that are based on cancer mutations, DNA sequencing technologies (e.g., genetic variants, whole-genome sequencing, exome sequencing), and genomic data...
sharing through genome-wide association studies also should be noted (Genetics Home Reference, 2014). As part of pharmacogenomics application for targeted therapies, understanding genetic variability in genes encoding drug-metabolizing enzymes, drug-transporting proteins, and drug receptors is essential. Clinical care of patients treated with genomic-based agents should include providing patients and their families with education about administration, toxicities, and symptom management.

Integrating genetics and genomics into clinical oncology practice depends on the practice focus, which could include risk prevention, risk reduction, or personalized targeted therapies. Professional educational resources can be found in Figure 1.

### Risk Assessment and Referrals

Clinical oncology nurses care for patients who need genetic testing and

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<tr>
<th>TABLE 1. Inherited Cancers, Genetic Mutations, and Molecular Targeted Therapies</th>
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<tr>
<td><strong>Type of Inherited Cancer</strong></td>
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<td>Cowden syndrome</td>
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<td>Driver mutations</td>
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<td>Familial adenomatous polyposis; attenuated familial adenomatous polyposis</td>
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<td>Hereditary breast and ovarian cancer</td>
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<td>Hereditary diffuse gastric cancer</td>
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<td>Hereditary prostate cancer</td>
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<td>Inherited genetic syndromes</td>
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<td>Li-Fraumeni syndrome</td>
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<td>Melanoma</td>
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<td>Molecular targets</td>
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<td>Multiple endocrine neoplasia</td>
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<td>Peutz-Jeghers syndrome</td>
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<td>Von Hippel-Lindau syndrome</td>
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<sup>a</sup>Men with *BRCA1* or *BRCA2* gene changes may also have an increased prostate cancer risk.

*Note. Based on information from National Cancer Institute, 2014a, 2014b; My Cancer Genome, 2014.*
counseling, as well as access to care for risk reduction. Identification of at-risk patients requires assessment using risk assessment tools and evaluating family history, with a minimum of a three-generation pedigree and including familial cancers (Valdez, Yoon, Qureshi, Green, & Khoury, 2010). Assessment also addresses environmental exposures (e.g., ionized radiation) and lifestyle factors (e.g., smoking, alcohol, diet) (National Coalition for Health Professional Education in Genetics [NCHPEG], 2007).

From the family history assessment, oncology nurses should identify the red flags of cancer risk (i.e., when cancer is diagnosed before age 50 years, affects multiple family members, absence of known risk factors, and consanguinity of family members) (NCHPEG, 2007). Guidelines for cancer risk assessment can be found from the American College of Obstetrics and Gynecology (Lancaster et al., 2007), American Gastroenterological Association (2001), National Comprehensive Cancer Network (INCCN, 2013), American College of Obstetricians and Gynecologists Committee on Gynecologic Practice (2011), and U.S. Preventive Services Task Force (2013).

Certified genetic counselors provide patient counseling and genetic testing (Accreditation Council for Genetic Counseling, 2013; Riley et al., 2012). The National Society of Genetics Counselors provides information about finding a genetic counselor, genetic testing overview, considerations, and resources for further patient and provider assistance (Riley et al., 2012). Social workers or financial counselors also can help patients gain access to genetic counseling and testing when issues arise, such as limited access, limited knowledge of services, or limited community resources. Uninsured and underinsured patients may be eligible for genetic testing financial assistance from local foundation support, institutional resources, public health programs, and nonprofit organizations (Cancer Resource Foundation, 2014).

Implications for Nursing

Many organizations advocate for genetics-related information and technology as a component of best practices in oncology care. Some of those organizations include the American Society of Clinical Oncology (Robson et al., 2010), Centers for Disease Control and Prevention (2011), U.S. Preventive Task Force (2005), and the World Health Organization (2014). Oncology nurses have a role in patient and family education, communication, decision support, and psychosocial support (Calzone, Jenkins, Nicol, et al., 2013; White, Bonham, Jenkins, Stevens, & McBride, 2008). Oncology nurses are part of a multidisciplinary team that includes physicians, genetic counselors, and social workers. As part of that team, nurses are responsible for educating and communicating cancer risk, follow-up for genetic testing and counseling, and facilitating preventive services in collaboration with primary care providers in community settings (Calzone, Jenkins, Nicol, et al., 2013).

In addition, management of patients’ genetic information involves knowledge of informed consent, use of bioinformatics to analyze data, and health information technology to advance early detection of risk and individualized care (Institute of Medicine, 2008; Khoury et al., 2007; U.S. Department of Health and Human Services, 2008). Nurses are involved with ethical, legal, and social implications related to bioethical issues of testing, patient fear of discrimination, and protection of patient information, including privacy and security concerns, as well as the effect on insurance coverage. To maintain privacy of genetic testing and mutation risk information, health policies include the Genetic Information Nondiscrimination Act, Affordable Care Act, and Americans With Disabilities Act (ADA) (National Human Genome Research Institute, 2012; Steck & Eggert, 2011).

In well-developed and insured populations, access to genetic testing, personalized medicine, and preventive treatment services is common. However, patients who lack access to as many resources also need genetic testing. Barriers to resources include inadequate financial coverage for genetic testing, the psychological impact on patients and families, and limits to preventive care for underprivileged populations within many U.S. and global communities (Brandt, Ali, Sabel, McHugh, & Gilman, 2008; Habin et al., 2010; World Health Organization, 2014).

Cultural considerations include stigma, fear, and mistrust surrounding genetic testing and care (Brandt et al., 2008; Schlich-Bakker, ten Kroode, Wârlâm-Rodenhuis, van den Bout, & Ausems, 2007). Domestic and international efforts focus on ethical implications of genetic testing that involve racial discrimination, preservation of human rights, informed consent, and cultural self-determination (MacIntosh, 2005). Healthcare providers, including nurses, will need ongoing education about genetics-based clinical care to combat cultural considerations (Institute of Medicine, 2008; World Health Organization, 2014).
Conclusion

Many resources support genomic and genetic oncology nursing competencies in practice, education, and research. Among those competencies are risk identification, initiating referrals to genetic counselors, and providing safe, informed treatment and follow-up care. Calzone, Jenkins, Bakos, et al. (2013) provided a framework for research to inform nursing practice and improve health outcomes. Nurses who are prepared in genetics and genomics essentials will provide high-quality, state-of-the-art clinical patient care.

References


Schlich-Bakker, K.J., ten Kroode, H.F.,...


Do You Have an Interesting Topic to Share?

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