Precision Medicine

Accelerating the science to revolutionize cancer care

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BACKGROUND: Precision medicine in cancer care uses specific information about a person’s tumor to help diagnose, plan treatment, prognosticate, and surveil throughout the cancer trajectory. Applications exist for cancer prevention, early detection, cancer treatment, and supportive care. Several national initiatives (e.g., National Cancer Moonshot Initiative) support these efforts to accelerate this science forward.

OBJECTIVES: This article presents an overview of the way in which precision medicine is revolutionizing cancer care.

METHODS: Definitions, historic perspectives, and specific examples are provided, which illustrate the use of precision medicine in cancer care.

FINDINGS: Oncology nurses and other healthcare professionals have a responsibility to learn about the science and national initiatives supporting precision medicine, provide clear patient education messages for optimal understanding, and address challenges.

KEYWORDS
precision medicine; cancer care; National Cancer Moonshot Initiative; oncology nurses

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PRECISION MEDICINE IS REVOLUTIONIZING CANCER CARE, and great potential exists to cure more types of cancer, increase survival, and improve overall patient care. The accelerated rate of precision medicine science requires nurses and others healthcare professionals to stay abreast of the latest advances in this area, which are vast. This article provides an overview of precision medicine, discusses the driving forces behind the precision medicine initiative, gives examples of precision medicine in cancer care, and highlights implications for patient care.

The definition of precision medicine has evolved with time. In its broadest sense, it is about developing and delivering the right approach (whether diagnostic or therapeutic) for the right person at the right time (Warner, 2017). It was historically called personalized medicine, but this was confusing in that people thought they were receiving “personalized” care; therefore, the term has shifted to “precision medicine” for disease prevention and treatment. The definition has evolved and become more accurate with time. Prasad and Gale (2017) analyzed “precision oncology” articles from 2005–2016 and saw a shift from a focus on targeted therapies, to treatment selection based on tumor biomarkers, to using next-generation sequencing to guide cancer treatment. They defined precision oncology as “directing therapy independent of cancer type as currently defined (based on anatomy and histology), and instead by mutation” (Prasad & Gale, 2017, p. 143). According to the National Cancer Institute ([NCI], 2017c), precision medicine is “a form of medicine that uses information about a person’s genes, proteins, and environment to prevent, diagnose, and treat disease. In cancer care, precision medicine uses specific information about a person’s tumor to help diagnose, plan treatment, monitor the effectiveness of treatment, or make a prognosis.” Unnecessary treatments also can be avoided if the individual’s profile does not match a particular therapy. Understanding precision medicine requires knowledge about the nomenclature of the field. Table 1 provides a glossary of terms.

Evolution of Precision Medicine

Traditionally, cancers were treated by site of origin, tumor histology, and extent of disease. As knowledge about the makeup of cancers and their growth mechanisms has been refined, this approach has changed. One early example is the ability to measure estrogen receptors on breast cancer cells and use those results to predict response to endocrine therapy. This became standard clinical practice in the 1970s and is still an important indicator, but the methods for testing have changed with time (McGuire, 1973). Another example is the ability to measure the expression of the human epidermal growth factor receptor 2 of the ERBB2 gene in breast cancer. Overexpression of
A genomic event that is potentially responsive to treatment with trastuzumab, which was approved by the U.S. Food and Drug Administration (FDA) in 1998 (Center Watch, 2017). Identification of the tyrosine kinase inhibitor imatinib is another example approved by the FDA in 2001 for use in diseases with the BCR-ABL fusion gene and in activated tyrosine kinases seen in chronic myelogenous leukemia and gastrointestinal stromal tumors (Center Watch, 2017). These examples were seen by many as proof of concept about tailoring treatment to targetable or actionable molecular or genomic findings in a tumor. Many more discoveries were made as improvements in molecular sequencing technologies became more efficient. Those changes are illustrated when looking at the knowledge that has been generated about non-small cell lung cancer (NSCLC). For example, in 1987, KRAS became part of the equation to treat NSCLC; EGFR was added in 2004; and BRAF, MET, and several other mutations have been identified since that time and are used as actionable targets in the treatment of NSCLC (Pao & Girard, 2011). Biomarkers direct about half of the systemic therapies used for NSCLC that are targeted to these mutations (Schwartzberg, Kim, Liu, & Schrag, 2017; Shea, Costa, & Rangachari, 2016).

### Precision Medicine Application in Cancer Care

Precision medicine has transformed cancer care and will continue to play a key role not only in the treatment of cancer, but also in cancer prevention, diagnosis, and supportive care. The following are some more common applications and specific examples for cancer care.

#### Cancer Prevention and Early Detection

Technological advances in gene sequencing are being used to analyze the biology of premalignancy. To date, most investigations have occurred in premalignant lesions of the lung. Loss of tumor suppression genes and amplification of oncogenes and driver mutations have been identified, which could lead to early detection of lung cancer and actionable targets amenable to cancer prevention strategies (Kensler et al., 2016). Cancer prevention trials also are underway. The first cancer prevention precision medicine trial was a randomized, placebo-controlled, double-blind trial of erlotinib versus placebo for the prevention of cancer in patients with high-risk oral premalignant lesions. Although erlotinib was not found to prevent cancer-free survival, loss of heterozygosity was found to be a prognostic tool for oral malignancy, which was a secondary aim of the study (William et al., 2016).

#### Diagnosis

Novel testing methods may prevent overdiagnosis and overtreatment of malignancy by identifying tumor growth rates and perceived responsiveness to treatment (NCI, 2017e). Diagnosis of prostate cancer through genomics is one example. Possible diagnostic biomarkers include ETS gene rearrangement, PTEN inactivation, and signaling of androgen receptors (Roychowdhury & Chinnaiyan, 2013).

### Cancer Treatment

The greatest abundance of research and most enthusiasm for precision medicine are in cancer treatment; these are being applied to current cancer treatment and modify the ways in which cancer is treated (Collins & Varmus, 2015). To bring a novel cancer treatment to market, actionable mutations first are identified as potential druggable therapeutic targets (NCI, 2017c). Several enabling components follow, beginning with a patient encounter to conduct “omics” profiling, then interpretation of data, development of hypothesis-driven trials, and determination of cancer management implications (Garraway, Verweij, & Ballman, 2013). A plethora of new treatments, which precisely target growth mechanisms of various types of cancers, are steadily in development. Examples of some of the actionable targets, related cancers, and treatment implications are in Table 2. Clinicians also

### Table 1. Precision Medicine Definitions

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
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<tbody>
<tr>
<td>Actionable mutation</td>
<td>A genomic event that is potentially responsive to a targeted therapy</td>
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<tr>
<td>Basket trial</td>
<td>Test the effect of one drug on a single mutation in a variety of tumor types.</td>
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<tr>
<td>Cancer genomics</td>
<td>Sequencing of DNA and RNA in cancer cells to identify molecular alterations that allow for cancer growth, metastasis, and drug resistance.</td>
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<tr>
<td>Genetics</td>
<td>The study of heredity and the variation of inherited characteristics</td>
</tr>
<tr>
<td>Genomics</td>
<td>Also known as “omics;” the study of the sequence of adenine (A), cytosine (C), guanine (G), thymine (T), or letters, within DNA.</td>
</tr>
<tr>
<td>Next-generation sequencing</td>
<td>Also known as high-throughput sequencing; a term used to describe modern DNA and RNA sequencing technologies</td>
</tr>
<tr>
<td>Omic profiling</td>
<td>Analysis of a tumor or other tissue to identify genomic, proteomic, or metabolic alterations of clinical importance</td>
</tr>
<tr>
<td>Omics</td>
<td>Exploration of the roles, relationships, and actions of the molecules that comprise the organism; includes genomics, proteomics, and metabolomics</td>
</tr>
<tr>
<td>Umbrella trial</td>
<td>Various treatment arms are available within one trial; treatment assignment is based on type of cancer and genomic makeup of the tumor.</td>
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Note. Based on information from National Cancer Institute, 2017c.
Supportive Care

Treatment-related toxicities can be highly variable; not all patients are at equal risk for their development. Precision medicine, through genomic information, is applied to identify which patients may be at greatest risk for toxicity and then to test treatment interventions. Because toxicities are biologically triggered, supportive care therapies that block or ameliorate toxicities can be developed. Desired outcomes will result in drugs that are beneficial but not toxic to patients (Sonis, 2015). Models are being developed that propose a common pathway to predict response. Alterovitz, Tuthill, Rios, Modelska, and Sonis (2011) identified unique gene clusters of patients and predicted the response to gamma-D-glutamyl-L-tryptophan, a treatment employed for oral mucositis. They differentiated between responders and nonresponders (Alterovitz et al., 2011). Supportive care precision medicine is lagging behind other efforts; more importance needs to be given to these trials, which will improve patient symptoms and quality of life.

Pharmacogenomics

Pharmacogenomics, the study of how genes affect individual responses to specific pharmacologic treatments, is another component of precision medicine and has important implications for cancer diagnosis, treatment, and supportive care. Investigation includes inherited genetic variations, as well as somatically acquired variants that can guide selection of anticancer therapy. Combining pharmacology with genomics can facilitate the development of safe and effective medications that are tailored according to individual genes. Pharmacogenetics involves genetic testing and searches for ways in which genes can activate or deactivate certain drugs (U.S. National Library of Medicine, 2017). Genes involved in drug metabolism and transportation (e.g., CYP2D6) have significant pharmacogenomic implications. Expression of this gene varies and is influenced by genetic polymorphisms, cytokine regulation, hormones and diseases, and personal factors, such as sex and age. Identifying specific expressions is beginning to lead to tailored medication prescribing (Zanger & Schwab, 2013).

One example of the importance of pharmacogenomics in cancer care involves the administration of irinotecan in colorectal

### Table 2.

<table>
<thead>
<tr>
<th>ACTIONABLE TARGET</th>
<th>CANCER TYPE</th>
<th>TREATMENT IMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALK</td>
<td>Lung (non-small cell), lymphoma (large cell), neuroblastoma</td>
<td>Alectinib, brigatinib</td>
</tr>
<tr>
<td>BCL-2</td>
<td>Chronic lymphocytic leukemia</td>
<td>Venetoclax</td>
</tr>
<tr>
<td>BCR-ABL</td>
<td>Chronic myelogenous leukemia</td>
<td>Imatinib</td>
</tr>
<tr>
<td>BRAF</td>
<td>Colorectal, melanoma, ovarian, thyroid</td>
<td>Cobimetinib</td>
</tr>
<tr>
<td>Epidermal growth factor receptor</td>
<td>Lung, colon</td>
<td>Gefitinib, imatinib</td>
</tr>
<tr>
<td>FLT3</td>
<td>Acute myeloid leukemia, mastocytosis</td>
<td>Midostaurin</td>
</tr>
<tr>
<td>Histone deacetylase</td>
<td>Lymphoma (T cell cutaneous), multiple myeloma</td>
<td>Panobinostat, romidepsin, vorinostat</td>
</tr>
<tr>
<td>Human epidermal growth factor receptor 2</td>
<td>Brain, breast, lung, ovarian, stomach</td>
<td>Trastuzumab</td>
</tr>
<tr>
<td>KRAS</td>
<td>Colorectal, lung, pancreatic</td>
<td>Little benefit from cetuximab and panitumumab</td>
</tr>
<tr>
<td>Mammalian target of rapamycin (mTOR)</td>
<td>Astrocytoma (subependymal giant cell), breast, pancreatic (neuroendocrine), renal</td>
<td>Everolimus, ridaforolimus, temsirolimus</td>
</tr>
<tr>
<td>MET (c-MET)</td>
<td>Lung (non-small cell), medullary thyroid</td>
<td>Cabozantinib, crizotinib</td>
</tr>
<tr>
<td>PARP</td>
<td>BRCA mutations (germline or somatic), fallopian tube, ovarian (epithelial), peritoneal</td>
<td>Niraparib, olaparib, rucaparib</td>
</tr>
<tr>
<td>Programmed cell death protein 1</td>
<td>Head and neck squamous cell, Hodgkin lymphoma, Merkel cell carcinoma, urothelial carcinoma</td>
<td>Atezolizumab, avelumab, durvalumab, nivolumab, pembrolizuma</td>
</tr>
</tbody>
</table>

*Note. Based on information from Center Watch, 2017; Cheng et al., 2016; National Cancer Institute, 2017e.*
cancer. Some patients have genetic variations that cause a shortage of UGT1A1, the enzyme that metabolizes irinotecan. This can lead to drug accumulation and toxicity, such as neutropenia, or other untoward effects. Patients with this genetic variant may need a lower dose that is equally effective but safer (Zanger & Schwab, 2013). A second example is genetic variability in the TPMT gene that affects the bioavailability of 6-mercaptopurine (6-MP) used in the treatment of leukemia. About 1 in 300 individuals are deficient in the gene, resulting in a decrease in 6-MP metabolism; hematologic toxicities can easily ensue (Rudin, Marable, & Huang, 2017).

**Initiatives Supporting Precision Medicine**
Moving the precision medicine agenda forward will require mass efforts to organize, fund, and deliver precision medicine effectively throughout the nation. The following are some of the most pivotal initiatives.

**Precision Medicine Initiative**
The Precision Medicine Initiative (PMI) was developed to “enable a new era of medicine through research, technology, and policies that empower patients, researchers, and providers to work together toward development of individualized care” (White House, 2016). The initiative, which focuses on identifying genetic changes and selecting the most effective treatment for individuals with those changes, was funded within the 21st Century Cures Act and includes funding for cancer-related programs, among others. PMI’s aims include (a) expanding precision medicine clinical trials, such as NCI-MATCH (Molecular Analysis for Therapy Choice) (NCI, 2017d), a basket study in which patients’ treatments are determined by their tumor’s genetic abnormalities, regardless of type of cancer; (b) overcoming drug resistance; (c) developing new laboratory models for research; and (d) developing a National Cancer Knowledge System to house and integrate tumor genomic information with clinical and outcomes data (NCI, 2017b).

**National Cancer Moonshot Initiative**
In 2016, then Vice President Joe Biden led an effort referred to as the National Cancer Moonshot Initiative, with the goal of making a decade’s worth of progress in cancer prevention, diagnosis, and treatment in just five years. The Blue Ribbon Panel was a scientific body convened to identify opportunities to achieve these goals (see Figure 1). Although all recommendations have direct or indirect implications for precision oncology, two recommendations from the Blue Ribbon Panel directly address it: immunotherapy, and prevention and early detection (Cancer Moonshot Blue Ribbon Panel, 2016a).

The immunotherapy recommendation to create a translational science network devoted exclusively to immunotherapy relates to approaches to activate and direct immune systems to prevent, attack, or kill cancer cells and to develop antitumor vaccines to prevent or treat cancers (Cancer Moonshot Blue Ribbon Panel, 2016b). To accelerate progress to do this, the Blue Ribbon Panel

**FIGURE 1.**
**BLUE RIBBON PANEL’S 10 TRANSFORMATIVE RESEARCH RECOMMENDATIONS**

- **ESTABLISH A NETWORK FOR DIRECT PATIENT INVOLVEMENT.** Engage patients to contribute their comprehensive tumor profile data to expand knowledge about what therapies work, in whom, and in which types of cancer.
- **CREATE A TRANSLATIONAL SCIENCE NETWORK DEVOTED EXCLUSIVELY TO IMMUNOTHERAPY.** Establish a cancer immunotherapy network to discover why immunotherapy is effective in some patients but not in others.
- **DEVELOP WAYS TO OVERCOME CANCER’S RESISTANCE TO THERAPY.** Identify therapeutic targets to overcome drug resistance through studies that determine the mechanisms that lead cancer cells to become resistant to previously effective treatments.
- **BUILD A NATIONAL CANCER DATA ECOSYSTEM.** Create a national ecosystem for sharing and analyzing cancer data so that researchers, clinicians, and patients will be able to contribute data, which will facilitate efficient data analysis.
- **INTENSIFY RESEARCH ON THE MAJOR DRIVERS OF CHILDHOOD CANCERS.** Improve understanding of fusion oncproteins in pediatric cancer, and use new preclinical models to develop inhibitors that target them.
- **MINIMIZE CANCER TREATMENT’S DEBILITATING SIDE EFFECTS.** Accelerate the development of guidelines for routine monitoring and management of patient-reported symptoms to minimize debilitating side effects of cancer and its treatment.
- **EXPAND USE OF PROVEN CANCER PREVENTION AND EARLY DETECTION STRATEGIES.** Reduce cancer risk and cancer health disparities through approaches in development, testing, and broad adoption of proven prevention strategies.
- **MINE PAST PATIENT DATA TO PREDICT FUTURE PATIENT OUTCOMES.** Predict response to standard treatments through retrospective analysis of patient specimens.
- **DEVELOP A 3-D CANCER ATLAS.** Create dynamic 3-D maps of human tumor evolution to document the genetic lesions and cellular interactions of each tumor as it evolves from a precancerous lesion to advanced cancer.
- **DEVELOP NEW CANCER TECHNOLOGIES.** Develop new enabling cancer technologies to characterize tumors and test therapies.

Note. Based on information from Cancer Moonshot Blue Ribbon Panel, 2016a.
recommended development of a clinical trial immunotherapy network and a cancer immunity atlas to create immunologic profiles of cancers and the genetic and environmental factors that may influence immunity (Jaffee et al., 2017).

The precision prevention and early detection recommendation to expand use of proven cancer prevention and early detection strategies is focused on learning from populations at highest risk for developing cancers—those with inherited germline mutations who tend to develop cancer more rapidly at earlier ages and are more likely to develop multiple cancers (Cancer Moonshot Blue Ribbon Panel, 2016c). Cancer-relevant gene–environment interactions and behavioral modifiers of cancer development and progression are being studied in two high-risk groups: (a) Lynch syndrome with a higher risk of colorectal, endometrial, and other cancers and (b) hereditary breast and ovarian cancer syndrome. Recommendations will include case ascertainment of high-risk individuals, delivery of genetic counseling, testing and monitoring, and the development of the Cancer Genome Atlas (TCGA). Exploring these two populations in depth will be prototypes for the other 50-plus hereditary cancer syndromes (Jaffee et al., 2017).

NCI (2017a) has issued a number of opportunities to address the Blue Ribbon Panel recommendations. To date, funding for these initiatives has come from the 21st Century Cures Act that included the Beau Biden Cancer Moonshot, named after Joe Biden’s son who died of a brain tumor in 2015.

Cancer Genome Atlas
To date, TCGA, a collaboration between NCI and the National Human Genome Research Institute (NHGRI), provides a comprehensive overview of the key genomics for 33 types of cancer and catalogs tumor profiles of somatically acquired mutations. A publicly available online database is comprised of more than two petabytes of genomic data to aid in the prevention, diagnosis, and treatment of cancer; researchers can access the dataset for further investigation (NCI, 2017c). Individuals must first have an eRA (electronic Research Administration) Commons account and then obtain permission and access information through NCI.

Implications for Healthcare Professionals and Oncology Nurses
Although genomics is moving forward quickly, genomic literacy has not kept pace. Precision medicine is a paradigm shift that will require nurses and other healthcare professionals to understand its various components and perspectives, including the taxonomy, historic perspectives, current initiatives, and applications to cancer care across the trajectory. In March, NHGRI proposed a Genomic Literacy, Education, and Engagement Initiative. The goal is to educate students from kindergarten through college, healthcare providers, and the general public about genomics. A detailed strategic plan is underway, and a variety of conferences are being conducted for teachers and other educators (NHGRI, 2017). With these new and evolving roles, nurses must understand and appreciate precision medicine ethics regarding privacy, confidentiality, and fairness, and implications for patient care, including patient education and communication.

Ethical Considerations
PMI calls for 1 million or more Americans who reflect the racial and cultural diversity of the United States to provide biospecimens for data mining, disease discovery, and research endeavors; the goal is to enroll all 1 million by the end of 2019 (White House, 2016). For cancer care specifically, patients are asked to provide biospecimens for biorepository and research purposes, but many also will provide specimens that will help direct their cancer treatment. In both cases, privacy, confidentiality, and fairness should be emphasized during the recruitment and informed consent process (Lemoine, 2014). Providing a thorough explanation for the testing is a first step. Based on the biorepository’s guidelines and intent, nurses should understand why blood, saliva, or tissue is requested from the patient, what it will be used for, and what the risks and benefits will be for the patient. As previously noted, in some cases, the specimens will be used to direct treatment decisions; others will be used for research purposes that may not affect the individual’s care but may affect future patients. Racially diverse populations deserve special attention. It is important that these patients not be coerced but understand the underrepresentation of minorities in research, which has led to a lack of understanding about the biologic differences and racial and ethnic heterogeneity in the molecular biology of cancer (Oruche, Carpenter, Renbarger, & Ross, 2016). Although tremendous benefits potentially exist for these understudied populations, trust should be developed over time to avoid widening the gap in healthcare disparities (Spratt et al., 2016).

“Novel testing methods may prevent overtreatment by identifying tumor growth rates and perceived responsiveness to treatment.”
Addressing genomic literacy is another key factor for successful implementation. One statewide precision medicine program found that building trust with research participants was noted as the key strategy for participant engagement. This begins with a transparent conversation explaining that every attempt will be made to protect the data, and, in the case of a breach, which occurs rarely, the participant would be notified. The most common reasons reported for declining participation in biorepository contributions include loss of privacy, concerns about data security, and fear of government intrusion that potentially could affect healthcare coverage (Oruche et al., 2016). Oncology nurses should be aware of the Genetic Information Nondiscrimination Act of 2008, which guarantees fairness in the use of genetic information. For example, it is considered illegal for an employer to take away healthcare coverage from or not hire someone based on genetic results (Human Genome Project Information Archive, 2014). The recruitment and informed consent process takes time and must be calculated into clinic work flow.

Ethical challenges will continue to arise—issues related to the ability to explain and obtain informed consent, the accuracy of the testing, and the meaning and management of mutations of unknown clinical significance (Hammer, 2016a, 2016b, 2017). Training the oncology workforce to be competent in these skills seems to be a daunting task, given the complex nomenclature needed to understand precision medicine, the advanced knowledge in biology and immunology, and the sensitivity of genetic and genomic testing to expand the science.

**Patient Care Considerations**

Understanding ethical concerns and patient implications of precision medicine will aid nurses and other providers in giving competent and safe care. Once patients have provided informed consent, nurses may need to obtain saliva or blood specimens. For other patients, pathologic specimens are required and may be previously collected, or the patients may need to schedule additional collection of tumor cells. First, tumor tissue is collected and sent to a molecular laboratory for characterization. A patient profile is mapped, and a genomics-enabled drug inference report is generated. Results then are interpreted by the clinical team or tumor board, and the patient is recommended for an appropriate trial (Siu, Conley, Boerner, & LoRusso, 2015). Patients should be aware of the possible eight-week lag time between specimen collection and results (Wućzik, 2016). The wait time can create significant anxiety, particularly if treatment is dependent on results, because the patient may be delaying other possible treatments during this wait time.

On receipt of results, nurses will use and interpret genetic tests as part of frontline care. To gain competence in this new role, nurses need to understand the basic science of genomics and understand cancer therapies that target genetic mutations and genomic variations. Those communicating data require special training on how information is shared. Some results will have implications for reproduction, which should be discussed with a genetic or psychological counselor. Personal attitudes can greatly influence patients’ and families’ acceptance of the results. Successful models are needed for data sharing and communication of implications, particularly in vulnerable populations (Frey, Bernstam, & Denny, 2016).

Challenges may exist regarding costs of testing and reimbursement, and genetic and genomic testing can be very expensive. Although clinical trials sometimes pay for the cost of testing during development, once approved, the costs will be left with patients and insurers. Prior authorization and a discussion of costs should occur prior to testing.

**Challenges in Precision Medicine**

Great progress has been made toward more precise cancer care, but many challenges remain (Fojo, 2016). First, a need exists to ensure reliable and valid diagnostic testing and empirical evidence in clinical trials to determine that this approach makes a difference in progression-free and overall survival (Prasad, Fojo, & Brada, 2016; Schwartzberg et al., 2017). Prioritizing which targets to pursue is another treatment challenge. Some fear that rare targets will be forgotten; ethical decision making will be important to set strategic priorities for this work.

A tremendous challenge for clinicians and researchers is keeping up with rapidly evolving concepts and findings (Lemoine, 2014). One of the greatest outcomes of the precision medicine initiative is generation of big data. Although this explosion of genetic and genomic information hopefully will aid in disease and treatment discoveries, the expansive data itself will require sophisticated informatics to manage data (Frey et al., 2016). In addition, learning systems will need to be created to understand data and their implications, communicate data to patients and families, and support the overall delivery of treatments generated by genetic and genomic targets (Frey et al., 2016). Precision medicine in cancer care also will require ready access to genomic data within the clinical workflow to facilitate point of care conversations about genomic findings and treatment implications (Warner, 2017). The number of potential mutations makes organization of data difficult for clinicians; therefore, clinical decision support systems are needed to help organize and synthesize this
information. Electronic algorithms are being developed to assist with this task (Warner, 2017).

**Conclusion**

Precision medicine has arrived, and clinicians and patients alike are hopeful for discoveries that will unlock the cure to many types of cancer. To date, advances already are abundant, and where the future will lead is unknown. National initiatives highlighted in this article are the driving force behind precision medicine. Applications for cancer are numerous and include novel ways to prevent, diagnose, and treat cancer, and to provide supportive care along the cancer continuum. However, this great initiative requires great responsibility. Nurses and other healthcare professionals are faced with learning details of precision medicine, which includes a new taxonomy that may be foreign to many of them. To communicate with patients and provide optimal patient care, tackling this head-on and becoming competent clinicians in this new era are imperative.

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