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Review

Precision health: A nursing perspective

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ABSTRACT

Precision health refers to personalized healthcare based on a person's unique genetic, genomic, or omic composition within the context of lifestyle, social, economic, cultural and environmental influences to help individuals achieve well-being and optimal health. Precision health utilizes big data sets that combine omics (i.e. genomic sequence, protein, metabolite, and microbiome information) with clinical information and health outcomes to optimize disease diagnosis, treatment and prevention specific to each patient. Successful implementation of precision health requires interprofessional collaboration, community outreach efforts, and coordination of care, a mission that nurses are well-positioned to lead. Despite the surge of interest and attention to precision health, most nurses are not well-versed in precision health or its implications for the nursing profession. Based on a critical analysis of literature and expert opinions, this paper provides an overview of precision health and the importance of engaging the nursing profession for its implementation. Other topics reviewed in this paper include big data and omics, information science, integration of family health history in precision health, and nursing omics research in symptom science. The paper concludes with recommendations for nurse leaders in research, education, clinical practice, nursing administration and policy settings for which to develop strategic plans to implement precision health.

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What is known?

- Precision health uses omic data within the context of lifestyle, social, economic, cultural and environmental influences to help individuals achieve well-being and optimal health.
- Nursing science has made monumental contributions to precision health through symptom science on manifestation and management of symptoms of disease and treatment.

What is new?

- Nurses are central experts for the routine collection of family history risk assessments, that is the most accessible and cost-effective way to guide precision health.
- It is imperative for the nursing profession to make strategic plans that promote precision health in nursing research, education, clinical practice, and administrative and health policy arenas.
- Nurses are well-positioned to lead the implementation of precision health through interprofessional collaboration, community outreach efforts, and coordination of care.

1. Introduction

In 2015, the Precision Medicine Initiative (PMI) was announced by President Obama to begin the “*All of Us*” longitudinal research cohort study to enroll one million participants from diverse U.S. communities and ethnic backgrounds, and examine associations among demographic, psychosocial, environmental and genetic/genomic data over 10 or more years of follow up [1–5]. Precision medicine is defined as “use of an individual’s genetic profile to guide decisions made in regard to the prevention, diagnosis, and treatment of disease” [2]. Recruitment progress in the PMI effort as of October 2019 is at >269,000 participants, >80,000 electronic health records, and >210,000 biosamples, and will feature a multitude of digital, genetic/genomic, clinical, biologic and electronic health information data, and will soon be available to nurse researchers wishing to conduct approved analyses [3–5]. Similar large-scale research initiatives to the U.S. PMI are emerging around the world [6–12].

Precision health is a term that refers to personalized healthcare based on a person’s unique genetic, genomic, or omic composition within the context of lifestyle, social, economic, cultural and environmental influences to help individuals achieve well-being and optimal health [1,13–15]. The successful implementation of precision health requires interprofessional collaboration, community outreach efforts, and coordination of care—a mission that nurses are well-positioned to lead. Despite the surge of interest and attention to precision health, omics, most nurses are not well-versed with the precision health goals or its importance for nursing science and practice. The purpose of this paper is to provide an overview of precision health and the importance of engaging the nursing profession to enhance personalized health care of individuals, families, communities, and populations.

2. Background

2.1. Precision medicine

The Human Genome Project (HGP) was an international, collaborative research program started in early 1990s, that

sequenced the human genome. In 2001, a publication by HGP in the journal *Nature* signified the era of genomics by announcing that 90% of the human genome’s more than three billion base-pairs had been sequenced [16]. In 2011, the National Academies of Sciences, Engineering, and Medicine published a consensus document that coined the term *precision medicine* as the “tailoring of medical treatment to the individual characteristics of each patient” and set the stage for subsequent advances in technologies and the use of omics data, including genomic, proteomics, metabolomics, microbiomics, for patient care [17].

The era of genomics (i.e. study of all the genes and their functions) represents a paradigm shift in healthcare focusing on the role of an individual’s genetic or genomic contribution to the health or development of disease as well as the impact upon treatment therapies and drug metabolism [18–20]. However, genetics/genomics falls short in fully describing the complexity of interactions of cell functions or within and across physiologic systems, and their impact upon health and disease [20]. Subsequently, a new field called “omics” emerged to better describe the molecular dynamic interaction of cells within and across physiologic systems [19–21]. Omics is the comprehensive study of metabolome or small molecules present in cells, tissues and body fluids encoded by the genome that provides a more detailed representation of the individual’s overall health status at the molecular level [21]. Thus omics includes genomics, epigenetics of methylomics and transcriptomics, proteomics, metabolomics and microbiomics [19–21]. The PMI has captured the attention of scientists, clinicians, policymakers, and the general public and aims to recruit one million participants follows to track their medical history, omic data, social determinants, health, and environmental exposures over time for 10 or more years [3–5]. Unique to this initiative, a wide range of under-represented minorities will be represented, and participants are given the option of receiving information on their omic health to inform their general healthcare provider, themselves, and their families [5].

Similar projects across the globe include the Veteran’s Administration health care Million Veteran Program, an observational cohort of ~1 million participants combining a mega-scale biobank with electronic health record (EHR) information; recruitment is currently at 700,000 [6]. UK’s NHS Genomic Medicine Service will expand on their 100,000 Genomes Project and UK Biobank’s 500,000 genomic medicine repository to sequence a total of 5 million genomes over 5 years [8,11]. France’s Genomic Medicine 2025 Program has invested \$745 million to build a network of sequencing and analysis centers capable of processing 235,000 genomes per year by 2020 [12]. The Genome India Project aims to initiate a biobank repository and sequence 10,000 human genomes and link this data to clinical information from selected hospitals [10]. China’s National Health and Medicine Big Data Center in Jiangsu Province is a 6 billion-yuan project that will combine health and medical information on 80 million patients with DNA sequencing capability of 400,000–500,000 individuals per year [9]. And lastly, the Hong Kong Genome Project aims to sequence 40,000–50,000 patients to improve the diagnosis and treatment of uncommon genetic disorders and cancers [7].

2.2. Precision health

Precision health, an evolution of precision medicine, combines genetic and genomic sequence, protein, metabolite, and microbiome information—collectively known as “omics”—with lifestyle, social, economic, cultural and environmental factors [15,22,23].

Such data can be informed by wearable devices, clinical information from electronic health records, to inform precise molecular taxonomies that specify disease diagnosis, treatment and prevention for a patient [15,22,23]. Nurse leaders have identified precision health as a priority for advancing nursing science because it considers individual variability in personal and environmental characteristics, including lifestyle, existing co-morbidities, biomarkers, cognitive and emotional factors, and genetic, epigenetic, and other omic factors [24].

Successful implementation of precision health requires inter-professional collaborations with computational data scientists, bioinformatics, statisticians, genomics medicine, and a range of multidisciplinary clinical content experts—of which nursing plays an essential role. Nurse scholars and leaders are strongly prepared and qualified to conduct clinical and translational scientific research, engage with patients and families, recruit subjects and monitor patient health and symptoms in interventional studies, and serve as powerful advocates for patients, families, communities, and populations. While the advent of precision health is a valuable opportunity for nurses and nurse leaders to advance nursing practice and science through innovative transformations in health care interventions, it also presents challenges such as the need for education, training, and knowledge of omics and precision health to incorporate these advances into nursing practice [25].

2.3. Big data and information systems

The PMI aims to create a healthcare database that follows each individual throughout their lifetime, tracking social determinants and exposures over time in the context of the individual's genomic and molecular makeup [3,4]. With the achievement of this goal, a large amount of data will be generated for each individual patient, i.e. “big data” [3,4]. The PMI functions as a data network that facilitates and integrates emerging research on the genomic and molecular makeup of diseases with clinical data on individual patients to drive the development of a more accurate disease classification and precision treatment [3,4]. The complexity of precision health involving big data regarding patients' personal omic information makes it essential for shared decision-making on disease treatment and management between healthcare providers and patients across the continuum of care settings. Thus, a major challenge in the era of precision health is to develop information technology systems that have the capacity to integrate and analyze big data for healthcare providers and patients through automated data visualization or algorithm development. Technology systems ultimately enable users to integrate comprehensive individual data that would lead to satisfying the goals of the PMI.

The US Office of the National Coordinator (ONC) for Health Information Technology has supported the effective use of health information and technology (IT) to help the nation achieving high-quality care while lowering costs [26]. The ONC's mission encompasses four major goals: (a) advance person-centered and self-managed health; (b) transform health care delivery and community health; (c) foster research, scientific knowledge, and innovation; and (d) enhance the nation's health IT infrastructure [26]. Identifying and standardizing use of omic data housed within individual patients' electronic health records is one element of ONC's strategic plan. Improving the processes of patient care is another way that PMI knowledge and clinical support tools can be used to further advance precision health [27]. The development of precision health technology systems will enable clinically meaningful integration of omic and other relevant personal data for individuals as well as accurate interpretation and utilization of such data. Given that nurses are at the frontline of patient care, it is necessary for nurses to be involved in the creation and successful

implementation of data gathered from the electronic medical record. As frontline healthcare providers, nurses can apply precision health for better to informed patient care, including treatment decisions, evaluation of treatment effectiveness, and monitoring and management of patient symptoms. This data is useful for monitoring patients' health, making treatment efficacy decisions, and monitoring changes in a patient's disease status.

ONC's leadership in promoting the inclusion and standards for omic data into patients' electronic medical records is an essential requirement for the development of the precision health system. Considering the important role of nursing in precision health, it is imperative for nurse leaders and nurses to take the initiative to participate in developing precision health systems. Nursing professional organizations, such as the American Academy of Nursing, can set up task forces to engage the ONC and other healthcare organizations to provide opportunities for patients and healthcare providers in providing input or feedback that ensures practical usefulness of omic data for patients, clinicians and insurance payers. Concerted efforts from nursing and other healthcare professions are needed to build an effective infrastructure for obtaining and analyzing input or feedback across systems and settings. This will require major strides in advancing knowledge in such key areas as omics, patient and family health literacy, research ethics/cultural and legal issues, vigilant assessment of patient preferences, and cost analyses. More details will emerge as the PMI proceeds and precision health advances.

3. A nursing perspective on precision health

The profession of nursing is the largest segment and a major driving force of healthcare and is the largest segment of the workforce. Nurses play a central role in healthcare to promote, protect and optimize health through holistic care of individuals, families, communities, and populations [36]. To advance precision health, nurses have promoted, protected, and optimized health through holistic evaluation of omics (i.e., biological variability) and environmental factors (i.e., family, environmental exposures), as well as social and economic determinants to evaluate their impact on biology (i.e., epigenetics), [14,36–38].

The holistic nursing approach to patient care expands on the traditional medical model focusing on disease treatment to include biological variability of genetics and genomics, family and social determinants of environmental factors and their impact on biology of epigenetics [37]. Nursing's holistic approach to patient care has positioned nurses as leaders to address critical issues of PMI and precision health where interprofessional collaboration is required for successful implementation [37]. Coordination of care, in which nurses play a critical role, is imperative to achieving the aims of PMI and precision health by improving personalized healthcare. This is accomplished by providing the right treatment, for the right patient, at the right time, and identifying omic and environmental factors and their interactions that contribute to or protect from common and complex diseases [1,37].

3.1. The role of nurses in precision health

The ultimate goal of PMI and precision health is to enhance precise diagnosis and personalized treatment of both rare and common diseases and to develop a new classification system that would align with greater utilization and application of omic data [13,37]. Significant advancements have been made to prepare the nursing workforce to drive scientific discoveries and use data to improve population health and prevention efforts. One example of this is nurses investigating the effect of genetic variance in genes (pharmacogenetics) or many genes simultaneously (pharmacogenomics) and how this modifies human

responses to pharmacological agents and diet [39,40]. By incorporating this knowledge into patient care, nurses can monitor and manage care with pharmacological agents to restore, maintain and promote patients' health. Thus, nursing in the omic era requires a focus on each individual's personal risk for disease and the effectiveness of treatments based on individuals' unique combination of genetic/genomic and environmental risk factors. The effort to include nursing in the leadership of PMI still faces challenges despite the fact that the nursing perspective is essential for successful implementation.

3.2. Genomics and nursing research: link with the National Institute of nursing research mission

As a unique domain of inquiry rooted to the philosophy of nursing practice, nursing science plays an essential role in the clinical and scientific enterprise. The National Institute of Nursing Research (NINR) National Institute of Nursing Research is the U.S. government's foremost institution supporting American nursing research, which aims to build the scientific foundation for clinical practice, prevent disease and disability, manage and eliminate symptoms caused by illness, and enhance end-of-life and palliative care [41]. Genomic and molecular correlates of health have long been a foci of nursing research. Beginning in 1999, the NINR held its first Summer Genetic Institute (SGI), a tuition-free, intensive research training program that provides nurses and nurse researchers with a foundation in molecular genetics appropriate for use in research and clinical practice. In 2000, NINR named genomics as a strategic theme for nursing research, which has led to the incorporation of genomic research over the past two decades [42].

NINR is also a pioneer in preparing researchers and clinicians in omics for precision health research and practice. NINR has been providing immersion training in omics over the past several years to prepare nurses for the integration of clinical and omic data. Since the summer of 2016, NINR has hosted a tuition-free, 1-week intensive training program, *Precision Health: From 'Omics' to Data Science Boot Camp*, led by nurse scientists with expertise in genomics, big data, or other omic research. The goal of this training is to engage and inform a diverse audience of nurse scientists, clinicians, graduate students, and faculty on the latest advances in genomics, pharmacogenomics, nutrigenomics (i.e. study of many genes simultaneously that modify human responses to food/nutrition), metabolomics, microbiomics (bacteria profiles), and data science. A unique and important focus of the program is the emphasis of ethical, legal, and social implications of precision health from the nursing perspective [43].

Symptom science is the study of symptoms related to a disease, or induced by treatment, and is an essential component of the precision health holistic understanding of disease phenotypes and the mechanism of symptoms [25,37]. Investigating omic associations in regard to symptoms is key to the discovery of their underlying mechanisms. Throughout its history, NINR has supported research and the training of researchers to develop personalized strategies to treat and prevent adverse symptoms, whether from illness or treatment [37]. The intramural research program at NINR includes a strong network of PhD-prepared nurse scientists who study the translation of clinical symptom observations using basic and biobehavioral omic research techniques. Foundational explorations are underway by intramural nurse scientists at NINR using the NIH-SSM including the evaluation of biomarkers in traumatic brain injury in collegiate athletes [44–46] and investigating associations and therapeutics of fatigue in cancer patients [47,48].

NINR has provided extramural funding on exploration of genomics and biomarkers leading to, or occurring with, persistent symptoms such as pain, fatigue, and sleep disturbance. Nurse scientists use genomics as potential markers of chronic pain

vulnerability, such as in patients with low back pain [19]. Other nurse scientists prospectively investigated the biological pathway of lymphedema symptomology using an omic approach and discovered that lymphedema symptoms have an inflammatory biological mechanism as evidenced by significant relationships with several inflammatory genes [49]. These areas of research are providing new insights that allow nurses and other healthcare professionals to identify the mechanism of symptoms and to develop precision management of symptoms, treatment, and disease.

Particularly relevant to the international community, NINR has played a pivotal role in the development of an Omics Nursing Science and Education Network (ONSEN) [50]. ONSEN is a collaborative effort between three NIH institutes, NINR, National Human Genome Research Institute and National Cancer Institute to develop an online resource database of available nurse scientist investigators and projects for which the broader international nursing professional community may engage and contribute to advancement of omic and precision health science [51]. ONSEN (<https://omicsnursingnetwork.net/>) provides information about: available nurse scientist principal investigators to collaborate with; available projects in various clinical specialties; common data elements to use in omic and precision health research studies; available mentors and other co-investigator and trainee resources; and information about key omic nursing science education content and skills (Genomic Knowledge Matrix) for which doctoral programs can implement at their academic institutions [52].

In summary, nursing science has made monumental contributions to symptom science through research on biological and clinical features, as well as the influence of environmental, behavioral, social, and economic factors in the manifestation of symptoms and their resolution [37]. Nursing in the omic era represents precision health that focuses on each individual's personal risk for disease conditions or effectiveness of treatments that are estimated directly from individual's unique combination of genetic/genomic and environmental risk factors.

3.3. Family health histories in the era of precision health

Obtaining and documenting an accurate family health history is a key nursing responsibility that can help identify the need for genetic testing for various disease conditions, such as familial hypercholesterolemia [28]. **Box 1** provides an example of the

Box 1

The Importance of Family Health History in the Era of Precision Health

Cardiovascular disease is one example of a disease that can be significantly prevented among family members with the implementation of a family health history which then can be applied to genetic screening. The identification of first-degree relatives (parents or siblings) with heart disease, age of onset, and other cardiovascular risk factors can help predict future risk for other family members. Siblings of individuals with a history of cardiac disease are at a 40% increased risk of developing heart disease, while having a parent with premature heart disease (before the age of 50 years) increases an individual's risk of developing heart disease by 60–75% [29]. Knowledge of such information could result in personalized cardiac screening, tailored risk factor reduction plans, early treatment and vigilant monitoring to prevent adverse outcomes.

importance of family health history in the era of precision health [29]. A comprehensive family health history includes gleaning information about all family members regarding their health, disease status, and causes of death [30,31]. Usually, family health information is conveyed to healthcare providers as part of patients' medical records through interviews by healthcare providers or clinical surveys completed by patients. Individuals usually obtain family health information through oral or written legacy of their family. However, not all individuals have access to their family's health information. Analysis of the information contained in a three-generation pedigree, for example which family member was the first to be diagnosed with a given disease such as cancer, provides insight into the patient's need for genetic/genomic counseling and testing. If a patient is found to carry a genetic mutation, a cascade screening method is recommended to achieve the identification and testing of other family members who may also be at risk. Cascade screening determines whether asymptomatic family members are also carriers of the identified mutation and proposes management options to reduce future harmful outcomes [28]. For example, in 2002, the Netherlands implemented a cascade-screening program for familial hypercholesterolemia for at-risk individuals, including school-aged children which led to the identification of more than 28,000 cases of hypercholesterolemia before symptoms occurred [28].

Advances in genetic research are creating new ways for individuals to take action specifically related to their family health history to prevent disease and improve their overall health [30,32]. Personalized genomic healthcare recognizes that a family history is central to guiding targeted prevention and disease management and nurses should be prepared to support the routine collection of family history risk assessments in electronic health records [31,33]. The family health history continues to be one of the simplest ways to access an individual's risk for a wide variety of conditions. Despite this knowledge, these discussions occur at approximately only half of all new clinical visits and a quarter of established visits and last an average of 2.5 min. A three-generation family health history can take up to 45 min to complete for an individual patient interviewed by a clinician (usually nurses or advanced practice nurses [APRNs]). Easily accessible tools that facilitate capturing and recording family history prior to seeing a healthcare provider are lacking. This is a critical gap in implementation of the PMI and precision health, in which nurses and advanced APRNs can play a critical role in taking accurate and thorough individual and family health histories, educating, and providing appropriate health interventions. A recent example of advances in this area is the implementation of three-generation family health histories for each patient by the National Institute of Health's (NIH) Clinical Center Nursing Department and Department of Clinical Research Informatics [34]. In this new pilot project, staff nurses will collect family health history information and create a pedigree diagram in the Clinical Research Information System that will be integrated into the electronic medical record for use by all health care team members (nurses, physicians, nurse practitioners, physician assistants, and genetic counselors). Further research with these pedigree diagrams will allow for improved understanding of optimal clinical workflows and predictive accuracy for specific health outcomes.

3.4. *Autonomy in sharing health information in the era of precision health*

Another aspect of precision health knowledge base construction will be designing systems to ensure that any omic testing and communication of test results aligns with patient and family preferences. This process should begin with having patient-centered

discussions about the meaning of specific tests, their results, risk/benefit considerations, and which results they want to receive. As patient advocates, nurses are well-versed in having difficult discussions with patients and family members as well as translating medical terminology into information that patients can understand. However, with the myriad of potential ethical and legal and social implications surrounding the sharing of patient data, data access, and privacy, the development of research and clinical practice protocols for dealing with these issues will be of paramount importance [35].

4. Recommendations for nursing strategic planning on precision health

Emerging science and longitudinal cohort research initiatives present a new era of precision health, yet there are many challenges that need to be fully addressed before it can be routinely utilized in healthcare systems. Considering the many facets of persons, omics, and environment, the nursing profession plays a critical role in making the paradigm shift from disease-focused treatment to one that utilizes precision health to prevent development of severe chronic conditions before they occur. To deploy omic knowledge into the healthcare enterprise, it is imperative for the nursing profession to make strategic plans that promote precision health in nursing research, education, clinical practice, and administrative and health policy arenas.

Nurses are well positioned to usher in this new era of precision health and lead its integration into health promotion, disease prevention, and treatment using nursing's holistic approach. The following recommendations are posited for nurses in research, education, clinical practice and health policy settings to translate and integrate precision health into the future of patient care.

4.1. *Recommendations for nursing research*

- Increase public and private funding to support key components in the preparation of tomorrow's nurse scientists who will conduct innovative research in precision health, particularly in the area of symptom science: the identification, categorization and optimal prevention and management of patient symptoms across the lifespan.
- Sustain continued support for innovative programs such as the NINR's intensive training programs on precision health: Graduate Partnerships Program, Postdoctoral Fellowships, Summer Genetics Institute, Data Science Boot Camp, and training internships or research rotations in the Symptom Science Center.
- Conduct nursing research that generates knowledge on the ideal formats and modalities of patient, family, and caregiver education, communication related to precision health and the prevention and management of symptoms.
- Conduct nursing research that identifies which interventions would promote the best health outcomes given patients' particular omic, genetic/genomic, digital, lifestyle and environmental characteristics.
- Develop reliable and valid patient outcome measures that can be used to evaluate effective precision health implementation at the healthcare provider level, clinic level, hospital/facility level, and health system level.
- Support innovative population-level research designs and scientific questions that examine genomic, omic, technology utilization in administrative databases to identify variation patterns and health system infrastructure deficiencies that prevent equitable access to precision health when managing symptoms in health systems or across populations.

- Support membership, growth, and participation in international nursing professional organizations with strong omic and precision health nursing research emphases, such as the International Society of Nurses in Genetics (ISONG), [53].

4.2. Recommendations for nursing education

- Integrate precision health concepts and skills (genetics, genomics, omics and data science) into all levels of nursing education (baccalaureate, advanced practice, and doctoral) as recommended by national, and international nursing consensus framework statements [52,54–56]. This includes exposure to use genetic/genomic information in student clinical experiences across the life span (prenatal health, neonatal/infancy/pediatrics, adult, older adult) and throughout the health and illness spectrum (acute care settings, public health and community settings, long-term care, etc.).
- Increase public and private funding for preparation of PhD nursing faculty to initiate and sustain the integration of precision health content throughout all nursing programs and curriculum accreditation standards.
- Develop precision health content for continuing education and training programs for all currently practicing licensed nurses. For states or provinces that may not have a continuing education requirement for renewal of nurse licensure (associate and baccalaureate, advanced practice), alternative mechanisms such as employer requirements will be needed.
- Support use of and participation in international nursing professional alliances with strong genetic/genomic education frameworks for which to implement omic and precision health nursing, such as the Global Genomics Nursing Alliance (G2NA), [57].

4.3. Recommendations for nursing clinical practice

- Advocate for the collection and inclusion of family health history and other social factors with omic data into patient care and electronic health record documentation.
- Develop accurate and understandable information content and patient education tools about precision health that empowers patients and informs the general population.
- Prepare practicing nurses across a range of health care settings are prepared to implement precision health, including: pharmacogenetics/pharmacogenomics-based drug administration, genetic test report information interpretation, and identification of high-risk family histories that warrant a referral to genetics counseling.
- Integrate nursing knowledge on precision health interventions is integrated into patient care workflows in ways that are safe and helpful to patients in making informed decisions about their care, without requiring excessive documentation requirements or time.
- Prepare baccalaureate and advanced practice nurses to pursue certification in genetics/genomics as a clinical specialty [53–55], and lead quality improvement implementation pilots of precision health interventions in their practice settings (i.e. family history pedigree assessments).
- Support use of and participation in international nursing professional alliances with strong genetic/genomic clinical practice frameworks for which to implement omic and precision health (G2NA), [57].

4.4. Recommendations for nursing administration and nursing policy

- Increase the support of precision health research and research training through activities in collaboration with federal and non-federal agencies.
- Support precision health systems, research, and training for nurse executives and leaders within healthcare systems. This includes but is not limited to: insertion of required electronic health record infrastructure to support precision health; facilitating point of care clinical decision support tools; knowledge of genetic experts in the field who can support these actions; and development of nursing practice policies (entry level and advanced practice nursing) at their institution to ensure safe patient care (i.e. informed consent for a genetic test, facilitating a referral to a genetics specialist, conducting and documenting a three-generation family history).
- Establish reimbursement from third party payors for precision health assessments that include family health history performed by the nurses and other health care providers.
- Develop policy solutions that protect patient confidentiality as much as possible for precision health issues not previously addressed or covered in the legislation. U.S. examples include modification of the Department of Health and Human Services' Health Insurance Portability and Accountability Act of 1996 (Pub.L. 104–191) and the Genetic Information Nondiscrimination Act of 2008 (Pub.L. 110–233). This includes various ethical, legal and social implications issues including privacy, protection of personal data from being used against employment and health insurance, and properly obtaining patient informed consent to store and use omic or other health related information.
- Support modernization and technologic innovation within healthcare systems and institutions in order to use genetic, genomic and -omic information to improve patient care and outcomes.
- Develop policies that support the safe integration of precision health information and services into health care operations (i.e.: laboratory standards compliance, omic tests with sufficient analytical validity, clinical validity and clinical utility, etc.).
- Increase the presence and participation of nursing clinicians, educators, and/or scientists, particularly those with genetic/genomic/omic training, on interdisciplinary teams and initiatives that involve implementation of precision health in healthcare institutions, health systems (i.e. Institutional Review Boards, Ethics Boards, Nursing Professional Practice Committees, Quality Improvement Committees, Genomic Advisory Committees, institutional advisory boards, etc.).

5. Conclusion

In conclusion, nurses across the globe are working toward developing and implementing precision health goals to generate new knowledge, health care infrastructure, and communication modalities that will help patients, families, communities, and populations. Nurses are vital members of the health care team. Nursing roles are paramount in the implementation of precision health, including precision delivery of medications based on knowledge of pharmacogenetics, providing patient and family education about the meaning of genomic or omic tests, performance of health and family assessments including the family history, and providing critical feedback and insight on feasibility of implementing new technologies into workflows at the clinical point of care. Regardless of the level of preparation, nurses in every clinical, education, research and policy setting have an interdisciplinary

team role to play in furthering the goals of precision health. Emerging science and research initiatives are generating cutting-edge innovations that capable of improving the diagnosis and personalized treatment for many individuals. As the largest clinical body of healthcare providers, the nursing profession can serve as a unifying and ubiquitous presence in the ethical and safe clinical translation, dissemination of omic advances in this new era of precision health, across the globe.

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Appendix A. Supplementary data

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