



Advancing nursing practice through genomic knowledge: Overcoming barriers and enhancing patient outcomes with personalized care

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Abstract

Background: Progress in genetic and genomic science is transforming healthcare, with considerable consequences for nursing practice. Genomic nursing incorporates genetic and genomic knowledge into patient care, facilitating improved individualized care plans, illness prevention, and treatment effectiveness. Nonetheless, obstacles such as inadequate genetic knowledge among nurses and insufficient systemic support impede its implementation.

Aim: This research aims to examine the incorporation of genetic and genomic knowledge into nursing practice, emphasizing its influence on enhancing patient outcomes and tackling obstacles to its implementation.

Methods: A thorough literature analysis was performed, integrating information from peer-reviewed journals, clinical recommendations, and case studies. The investigation concentrated on the function of nursing in genomic medicine, patient outcomes linked to genomic interventions, and systemic obstacles to the integration of genomic nursing.

Results: Genomic nursing has shown quantifiable advantages, such as improved diagnostic precision and individualized treatment strategies. Successful case studies in oncology, cardiology, and uncommon diseases highlight the significance of genomic knowledge in enhancing patient outcomes. Nonetheless, substantial obstacles, including insufficient genetic information in nursing curricula, ethical dilemmas, and limitations in institutional resources, persist.

Conclusion: Genomic nursing is essential for enhancing individualized patient care and tackling intricate healthcare issues. Significant efforts are required to improve genetic literacy among nurses, promote interdisciplinary collaboration, and provide supporting policies and infrastructure. Subsequent study must concentrate on mitigating systemic obstacles and enhancing genomic nursing methodologies to elevate healthcare outcomes.

Keywords: Genomic nursing, genetic knowledge, patient care, personalized medicine, nursing interventions, genomic literacy

Introduction

The incorporation of genetic and genomic knowledge into nursing practice, known as genomic nursing, signifies a significant leap in healthcare. Genomics, the examination of an individual's entire gene set and their interactions with one another and the environment, has transitioned from theoretical research to practical applications that impact illness prevention, diagnosis, and treatment [1]. The integration of genomics in nursing allows healthcare providers to offer personalized treatment based on patients' genetic profiles, hence improving the precision and effectiveness of clinical interventions. This domain is supported by frameworks like the Precision Medicine Initiative, which highlights the significance of genomes in customizing healthcare to individual differences [2].

The importance of genomic nursing resides in its capacity to transform patient care, especially for intricate situations including cancer, cardiovascular diseases, and rare genetic

abnormalities. Nurses, as primary healthcare practitioners, are essential in connecting genetic science with clinical practice. This encompasses duties such as gathering family health histories, instructing patients on genetic testing, and analyzing genomic data in relation to care provision. Notwithstanding its potential, genomic nursing encounters obstacles, such as insufficient genomic literacy among nurses and ethical dilemmas regarding the confidentiality of genetic information [3,4].

Recent advancements in genomic technologies have broadened the scope of genomic nursing. The advent of cost-effective next-generation sequencing has facilitated extensive genomic investigations, allowing for the detection of hereditary susceptibilities to illnesses [5]. Advancements in pharmacogenomics enable the personalization of medication therapy according to genetic profiles, hence minimizing adverse drug reactions [6]. The creation of worldwide genetic databases has enabled extensive study

and cross-border collaboration, enhancing the generalizability of genomic discoveries [7]. This study is organized to offer a comprehensive examination of genomic nursing, commencing with an in-depth overview of the incorporation of genetic knowledge into nursing practice. The following sections will examine the utilization of genomics in clinical environments, emphasizing its influence on patient outcomes and addressing systemic and policy-related obstacles. The report concludes with suggestions for future research and methods to improve genetic literacy among nursing workers.

Genomic Literacy in Nursing

The incorporation of genomics into nursing practice requires a fundamental comprehension of genetic and genomic principles, together termed genomic literacy. Despite the increasing significance of genomics in personalized healthcare, substantial deficiencies persist in the training of nurses to implement genomic knowledge in clinical environments. The disparities stem from educational obstacles, insufficient professional development opportunities, and the irregular integration of genetic capabilities into nursing curricula (Fig 1)

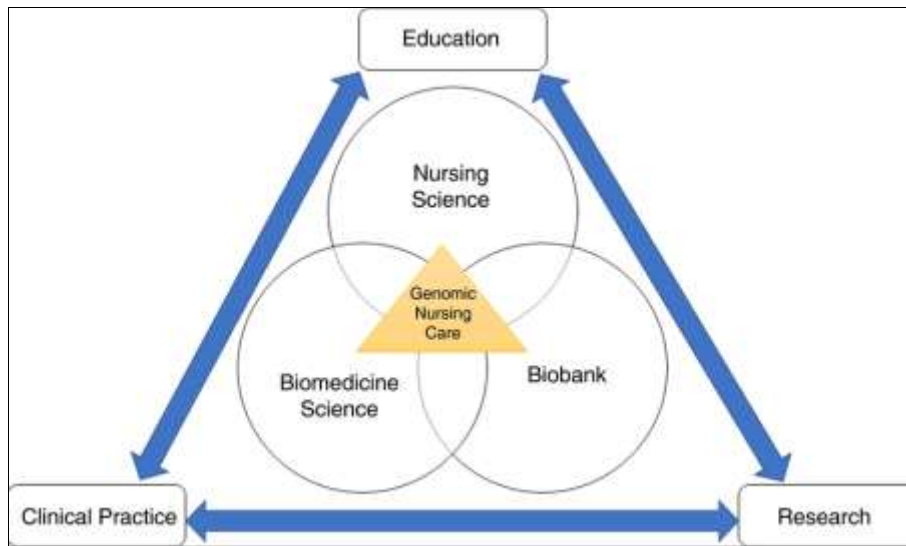


Fig 1: Conceptual framework of genomic nursing care.

Educational Challenges

A major obstacle to genomic literacy in nursing is the insufficient inclusion of genomic knowledge in nursing courses. Numerous nursing programs, at both undergraduate and postgraduate levels, offer limited exposure to genetics and genomics, resulting in graduates being inadequately prepared for the requirements of contemporary healthcare [8]. Although other healthcare fields, including medicine and pharmacy, have progressively embraced genomic ideas, nursing education frequently trails in this aspect. This disparity may lead to knowledge limitations that hinder nurses' effective participation in genomic-based treatment. A significant difficulty is the scarcity of accessible professional development opportunities in genomics. Nurses frequently encounter obstacles, including time limitations, budgetary constraints, and inadequate institutional support, while seeking to improve their genetic knowledge via continuing education [9]. A recent poll of nurses indicated that more than 60% felt insufficiently equipped to analyze genomic data or advise patients on genetic testing outcomes [10]. Overcoming these obstacles is essential for preparing nurses with the competencies required for their advancing responsibilities in genomic healthcare.

Strategies for Improvement

To enhance genomic literacy, strategies should prioritize the integration of genomics into the foundational framework of nursing education and professional development. The incorporation of genetics into both undergraduate and postgraduate nursing programs is imperative. Programs

must have specialized modules that deliver both theoretical and practical instruction in genetics and genomics, guaranteeing that nursing students attain a thorough comprehension of these principles prior to clinical experience [11]. Educational institutions may partner with genomic specialists to develop curricula specifically addressing the requirements of nursing, encompassing patient assessment, genetic counseling, and ethical considerations.

Certification programs and online courses are essential in bridging genetic literacy gaps among working nurses. Professional organizations, like the American Nurses Association (ANA) and the International Society of Nurses in Genetics (ISONG), have created genomic education tools comprising self-directed online modules and certification programs. These programs allow nurses to obtain specialized skills without interfering with their clinical duties [12]. Moreover, healthcare companies can bolster these activities by providing incentives, such as cash reimbursement or acknowledgment for achieving genomic certifications.

Professional Competencies

Attaining genetic literacy necessitates compliance with the professional competencies established by prominent organizations. The ANA and ISONG have produced recommendations that delineate the fundamental competencies required for genomic nursing practice. These encompass the capacity to gather and analyze familial health histories, evaluate patient susceptibility to genetic disorders, and integrate genomic insights into care strategies [13].

Nurses are also need to consider ethical and psychosocial dimensions of genomics, including informed consent, privacy issues, and genetic discrimination.

Competencies are increasingly contextualized within interprofessional collaboration, since genomic medicine frequently necessitates teamwork among other disciplines, including genetics specialists, counselors, and physicians [14]. The utilization of these competences guarantees that nurses effectively engage in genomic-based care and fulfill their responsibilities as patient advocates and educators.

Improving genomic literacy among nurses is crucial for the advancement of personalized healthcare and maximizing the potential of genetic medicine. Addressing educational obstacles, executing focused methods for enhancement, and promoting compliance with professional competencies will equip nurses to fulfill the requirements of genomic-based care. Future research and policy activities must concentrate on assessing the efficacy of these measures and discovering supplementary methods to enhance genetic literacy in nursing.

Application of Genomics in Nursing Practice

The incorporation of genetics into nursing practice has revolutionized patient care, allowing healthcare personnel to implement more accurate, individualized strategies for diagnosis, treatment, and management. Genomic applications in nursing include treatments in particular therapeutic domains, the utilization of genomic data for patient management, and the navigation of ethical and collaborative problems. Nurses can utilize genomics to improve patient outcomes and advance the objectives of precision medicine.

Case Studies

Genomic interventions in clinical practice have significantly influenced oncology, cardiology, and uncommon disorders. In oncology, genomic nursing has facilitated the precise identification of hereditary cancer syndromes, including BRCA1 and BRCA2 mutations associated with breast and ovarian malignancies. Nurses are essential in assisting patients with genetic testing, counseling, and risk-reduction initiatives [15]. Furthermore, genomic screening of tumors enables nurses to facilitate tailored therapy, such as trastuzumab for HER2-positive breast cancer, which have shown enhanced survival outcomes [16].

In cardiology, genomic nursing interventions are essential for recognizing genetic predispositions to illnesses such familial hypercholesterolemia and hypertrophic cardiomyopathy. Nurses facilitate the collection of comprehensive family histories and coordinate genetic testing to identify persons at risk, thereby enabling early intervention through lifestyle changes and pharmaceutical treatments [17]. Likewise, genomic knowledge regarding rare disorders, such cystic fibrosis and Duchenne muscular dystrophy, has enhanced early detection and treatment. Nurses in specialized care teams offer crucial assistance to patients and families, tackling the emotional difficulties linked to these diseases while assuring compliance with treatment protocols [18].

Patient Management

The incorporation of genetic data into nursing practice has

improved patient management, especially in history-taking and care planning. Detailed family health histories, fundamental to genomic nursing, enable nurses to discern patterns of hereditary illnesses and categorize patients based on genetic risk. This information guides screening suggestions, preventive measures, and individualized care programs [19]. In pharmacogenomics, nurses utilize genetic information to inform medicine choices and dosages, thereby reducing adverse drug responses and enhancing therapeutic effectiveness [20].

The implementation of electronic health records (EHRs) has enabled the incorporation of genetic data into therapeutic processes. Genomic annotations in electronic health records enable nurses to obtain essential information at the point of care, ensuring that genetic factors are included into decision-making processes. Nurses work as middlemen between patients and multidisciplinary teams, converting intricate genomic data into practical insights that correspond with patient values and preferences [21].

Ethical Considerations

The utilization of genomics in nursing practice presents considerable ethical dilemmas, encompassing concerns around genetic discrimination and informed consent. Genetic discrimination, characterized by the improper utilization of genetic information by employers, insurers, or other entities, continues to be a concern despite statutory safeguards like the Genetic Information Nondiscrimination Act (GINA) in the United States. Nurses are essential in informing patients of their rights and promoting fair access to genomic services [22].

Informed consent constitutes a fundamental principle of ethical genomic activity. Nurses must guarantee that patients comprehensively comprehend the ramifications of genetic testing, encompassing prospective psychological effects, familial consequences, and the likelihood of ambiguous or inadvertent results. Nurses enhance clear communication and offer emotional support, enabling patients to make educated decisions that reflect their personal and cultural values [23]. Ethical practice necessitates awareness of the varied opinions and desires of patients, especially in multicultural contexts where views on genetic testing and genomics can differ significantly [24].

Collaborative Practices

Effective genomic care requires interdisciplinary coordination among healthcare experts. Nurses collaborate with geneticists, physicians, counselors, and pharmacists to provide holistic treatment that incorporates genomic knowledge. In oncology, tumor boards frequently incorporate nurses who provide their skills in patient education and care coordination, ensuring that genetic discoveries are converted into relevant treatment strategies [25].

Collaborative practices encompass research and policy formulation. Nurses engage in genetic research projects, aiding in the creation of knowledge that guides best practices and policy recommendations. Nurses facilitate the integration of genetic science into clinical practice through cross-disciplinary initiatives, ensuring that genomic advancements are effectively incorporated into routine care [26].

Impacts on Patient Outcomes

The incorporation of genetics into nursing practice has markedly improved patient outcomes, especially through its impact on diagnosis, therapy customization, education, and psychosocial assistance. Genomic nursing empowers healthcare professionals to transcend conventional uniform strategies, delivering customized therapies that cater to individuals' distinct genetic profiles and related risks. Nurses, as primary caregivers, are essential in enhancing these outcomes by integrating genetic knowledge into holistic patient care.

Enhanced Diagnostics

Genomic testing has transformed diagnostics by facilitating the detection of genetic susceptibilities to diseases and the formulation of preventive strategies. Nurses can utilize genetic risk assessments to identify individuals with hereditary disorders, including Lynch syndrome, which increases the risk of colorectal and endometrial malignancies, and BRCA1/BRCA2 mutations, linked to breast and ovarian cancers [27]. Timely identification of these predispositions enables preemptive screening and risk mitigation techniques, such as lifestyle alterations, preventive procedures, or medicinal therapies.

Moreover, genomic diagnostics have demonstrated their critical role in detecting uncommon genetic abnormalities. Conditions like Fabry disease and Marfan syndrome, which frequently evade conventional diagnostic techniques, are now more easily identified with next-generation sequencing technologies. Nurses have a crucial role in gathering comprehensive family histories and orchestrating diagnostic procedures, hence facilitating prompt and precise diagnosis [28]. Polygenic risk scores (PRS) facilitate the stratification of individuals' risks for prevalent diseases, including cardiovascular problems and type 2 diabetes, hence enabling more targeted preventive interventions [29].

Personalized Treatment

Genomic discoveries have significantly influenced therapy pathways by facilitating individualized therapeutic strategies. Pharmacogenomics, the examination of the impact of genes on personal pharmaceutical reactions, has guided the implementation of genetic testing to enhance drug selection and dosage. Nurses have a crucial role in the implementation of pharmacogenomic data, especially in oncology and psychiatry [30]. In oncology, tumor genomic analysis has informed the application of targeted medicines, including pembrolizumab for patients exhibiting high microsatellite instability and EGFR inhibitors for non-small-cell lung cancer, markedly enhancing survival rates [31].

Case studies further highlight the significance of genetic medicine. In cardiology, identifying a CYP2C19 gene polymorphism in patients needing antiplatelet therapy can inform the selection between clopidogrel and alternative drugs, thereby mitigating the risk of adverse cardiovascular events. Patients with uncommon disorders, such as spinal muscular atrophy (SMA), now benefit from gene therapies like nusinersen that address the underlying genetic abnormality. Nurses offer essential assistance during various therapeutic procedures, from delivering therapies to assessing outcomes [32].

Patient Education

Patient education is fundamental to genomic nursing, as the intricacy of genomic information necessitates clear communication to facilitate informed decision-making. Nurses serve as educators, assisting patients and their families in comprehending the ramifications of genomic test outcomes. This encompasses elucidating the importance of pathogenic variations, assessing risk levels, and deliberating on available preventive or therapeutic alternatives [33].

A patient informed of their heightened genetic predisposition to Alzheimer's disease via APOE genotyping may necessitate assistance with lifestyle modifications to reduce risk. Nurses elucidate genetic findings, promoting patient engagement and empowerment. They also confront prevalent myths and anxieties regarding genetic testing, ensuring that patients make informed decisions based on precise and understandable information [34].

Psychosocial Support

The emotional and social ramifications of genetic findings are considerable, as patients frequently contend with fear, guilt, or doubt regarding their results. Nurses offer psychosocial care by meeting emotional needs and linking patients to suitable resources, such as counseling services or support groups. This is especially crucial when genetic testing indicates a significant risk of acquiring severe or life-threatening illnesses [35].

A patient with a newly discovered pathogenic BRCA1 mutation may have concerns regarding cancer risk, familial implications, and possible preventive strategies. Nurses provide empathetic support, assisting patients in managing their emotions and making informed choices regarding risk-reduction techniques. In multicultural environments, nurses take into account cultural and social aspects that affect patients' interpretations of genetic data, ensuring that care is customized to align with individual values and beliefs [36].

The use of genetics into nursing practice has resulted in significant enhancements in patient outcomes in diagnoses, treatment, education, and psychosocial care. Nurses facilitate the implementation of precision medicine by enabling early detection of illness risks, customizing medications based on individual genetic profiles, and considering the wider implications of genomic discoveries. Ongoing initiatives to improve genomic literacy and support frameworks for nurses will guarantee the comprehensive integration of genomic advancements into clinical practice.

Systemic and Policy Implications

The incorporation of genetics into nursing practice is a complex problem that transcends clinical application to include systemic and policy factors. Institutional preparedness, financial priorities, research requirements, and global viewpoints are all crucial factors influencing the success of genomic nursing. Addressing these factors is crucial for developing a healthcare system that maximizes the potential of genetics while guaranteeing equitable access and superior care.

Institutional Challenges

A key obstacle to the incorporation of genomics into nursing practice is the insufficient institutional preparedness. Resource constraints, such as inadequate genomic

infrastructure, insufficient training opportunities, and a shortage of trained professionals, hinder healthcare institutions from implementing genomic practices. A review of healthcare facilities indicated that merely 35% have access to genetic counselors or specialists to facilitate genomic projects, resulting in substantial deficiencies in care delivery^[37].

Institutional issues are exacerbated by technological constraints, including the absence of compatibility between electronic health records (EHRs) and genomic databases. Nurses frequently face challenges in accessing and exploiting genetic data at the point of treatment, hence diminishing the efficacy of tailored therapies^[38]. Moreover, numerous institutions lack rules or guidelines for the integration of genomic nursing into standard practice, leading to inconsistent implementation and disparate patient outcomes^[39].

Policy Recommendations

The effective incorporation of genetics into nursing practice necessitates strong legislative frameworks that set standards, distribute funds, and encourage genomic education. Promoting genomic nursing standards is essential for ensuring that nurses have the necessary competences to provide genomic care. Organizations like the International Society of Nurses in Genetics (ISONG) and the American Nurses Association (ANA) have established competency frameworks; nevertheless, wider implementation and enforcement at institutional and governmental levels are essential^[40].

Prioritization of funding for genomic nursing education and infrastructure is essential. Governments and healthcare organizations ought to allocate resources towards genetic literacy initiatives, encompassing undergraduate and postgraduate curriculum, professional certifications, and continuing education opportunities. These initiatives will enable nurses to analyze genomic data, instruct patients, and participate in interdisciplinary care teams^[41]. Additionally, public financing for genomic infrastructure, including EHR integration and genomic testing facilities, will mitigate systemic obstacles to deployment.

Research Needs

Notwithstanding substantial progress, notable deficiencies in genomic nursing research persist, especially concerning the assessment of genetic interventions and their effects on patient outcomes. Research priorities encompass the formulation of evidence-based guidelines for genomic nursing practice and the evaluation of the cost-effectiveness of genomic applications in nursing^[42]. Studies establishing the long-term advantages of pharmacogenomics in mitigating adverse drug reactions or improving medicine efficacy are crucial to substantiate investment in genomic nursing^[43].

Additionally, research is needed to address the ethical, legal, and social implications (ELSI) of genomic care, particularly in diverse communities. Comprehending the impact of cultural and socioeconomic aspects on patient perceptions of genomics will inform the creation of culturally attuned care approaches. Nurses, as reliable patient advocates, are distinctly qualified to spearhead research in this domain, enhancing inclusive and equitable genomic practices^[44].

Global Perspectives

The incorporation of genomic nursing differs markedly among global healthcare systems, illustrating variations in resources, governmental priorities, and cultural contexts. Affluent nations, including the United States, the United Kingdom, and Australia, have significantly advanced the integration of genetics into nursing education and practice. The United Kingdom's 100,000 Genomes Project has created a framework for incorporating genetic data into clinical workflows, with nurses serving a pivotal role in patient education and data collecting^[45].

Conversely, low- and middle-income nations encounter substantial obstacles to genetic integration, such as inadequate finance, infrastructural deficiencies, and a scarcity of educated professionals. Collaborative initiatives like the Global Genomic Nursing Alliance (G2NA) seek to rectify these inequities by offering resources, training, and advocacy for genomic nursing globally^[46]. These initiatives underscore the necessity for international collaborations to guarantee the equitable distribution of genetic gains among populations.

Conclusion

The incorporation of genetics into nursing practice signifies a significant change in the provision of individualized, accurate, and patient-focused care. Equipping nurses with the skills to utilize genetic knowledge enables healthcare systems to tackle intricate health issues, bolster illness prevention, and increase treatment results. This paper emphasizes the essential function of genomic nursing in diagnosis, tailored therapy, patient education, and psychosocial support, while also identifying systemic problems and policy implications that need to be addressed to optimize its potential.

Institutional obstacles, such as resource constraints and insufficient genetic infrastructure, highlight the necessity for significant expenditures in education, technology, and interdisciplinary cooperation. It is essential to implement policy proposals that establish genomic nursing standards, guarantee equal resource access, and incorporate genomic data into clinical workflows to build a strong foundation for genomic nursing. Furthermore, investigations into the long-term effects of genetic interventions, together with their ethical and cultural implications, will furnish the necessary information to guide best practices.

The global discrepancies in the application of genomic nursing illustrate the differing preparedness of healthcare systems to embrace this novel methodology. Collaborative initiatives, including international partnerships and shared frameworks, are crucial for guaranteeing fair access to genetic advancements across diverse populations and contexts.

As genomics advances, nurses will continue to lead this paradigm change, connecting scientific innovation with patient care. By tackling systemic and policy-level obstacles, stakeholders may guarantee that genomic nursing is included into contemporary healthcare, thereby enhancing outcomes and promoting global health equity.

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تعزيز ممارسة التمريض من خلال المعرفة الجينية: تجاوز العوائق وتحسين نتائج المرضى من خلال الرعاية الشخصية

الملخص

الخلفية: يمثل التمريض الجينومي تطورًا مهمًا في مجال الرعاية الصحية، حيث يساهم في تعزيز الرعاية الشخصية للمرضى بناءً على ملفاتهم الجينية. يعتمد هذا النهج على استخدام الاختبارات الجينية والجينومية لتحديد مخاطر الأمراض، وتخصيص استراتيجيات الوقاية والعلاج. ومع ذلك، تواجه الممارسة تحديات كبيرة مثل نقص التدريب الكافي للتمريض على المعرفة الجينومية، وضعف البنية التحتية الداعمة لها.

الهدف: يهدف هذا البحث إلى دراسة كيفية دمج المعرفة الجينية والجينومية في الممارسات التمريضية وتأثيرها على تحسين نتائج المرضى، بالإضافة إلى مناقشة العوائق والسياسات المطلوبة لتعزيز هذا التخصص.

الطرق: تم إجراء مراجعة شاملة للأدبيات العلمية التي نشرت. ركزت المراجعة على التطبيقات السريرية للتمريض الجينومي، بما في ذلك التشخيصات المحسنة، والعلاجات المخصصة، والتثقيف الصحي، والدعم النفسي الاجتماعي.

النتائج: أظهرت الدراسة أن التمريض الجينومي يعزز من دقة التشخيص، ويتيح تقديم علاجات شخصية تعتمد على البيانات الجينية، ويؤدي إلى تحسين إدارة الحالات المعقدة مثل السرطانات، والأمراض القلبية الوراثية، والأمراض النادرة. كما أن دور التمريض في توجيه المرضى لفهم النتائج الجينية ودعمهم نفسيًا واجتماعيًا كان له أثر إيجابي على جودة الرعاية.

الخلاصة: يمثل التمريض الجينومي مستقبلًا واعدًا في مجال الرعاية الصحية، حيث يعزز من الرعاية الشخصية ويحسن النتائج الصحية. ومع ذلك، يجب مواجهة التحديات المؤسسية وتطوير سياسات داعمة لتوسيع تطبيق هذا المجال. كما أن هناك حاجة ماسة إلى تعزيز التعليم الجينومي والبحث العلمي لتحديد أفضل الممارسات ودعم التكامل الفعال للتمريض الجينومي في نظم الرعاية الصحية عالميًا.

الكلمات المفتاحية: التمريض الجينومي، الرعاية الشخصية، المعرفة الجينية، التثقيف الصحي، الدعم النفسي الاجتماعي، السياسات الصحية.

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