

# Leading Canadian Nurses into the Genomic Era of Healthcare

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## Abstract

Genomics is having a profound impact on every aspect of healthcare. To support nurses to develop genomic literacy and integrate genomics into care, an engagement framework was created. The framework uses principles of nursing intraprofessional collaboration, the knowledge-to-action cycle and the diffusion of innovations theory. This framework was used to identify six key priorities for action and leadership strategies to accelerate and sustain the nurses' engagement with genomics. With leadership and genomic literacy, nurses can fully participate in the creation and implementation of new care pathways, deliver education, advance research linked to genomics and improve patient experience and health outcomes.

## Introduction

Scientific advancements in genetics (study of individual genes) and genomics (study of a person's genes and the interaction of those genes with the environment) are having a profound impact on every aspect of healthcare. Genomic discoveries are leading to new models of care called precision and personalized healthcare. These models include new approaches to disease prevention, diagnosis, treatment and follow up that are tailored to the characteristics of the

individual. In Canada, however, there is little education or support to assist nurses in developing genomic literacy (the ability to understand and use genomic information) and integrating genomics knowledge into practice. Nursing leadership is needed to address these gaps so that nurses can fully participate in the genomic era of healthcare. With leadership, nurses can develop genomic literacy and fully participate in developing new care pathways, delivering education and advancing research linked to genomics. While the nurses' responsibilities will influence the breadth and depth of required knowledge, all nurses will require genomic literacy to provide safe, ethical and compassionate care in the genomic era (Fu et al. 2020).

A team of researchers collaborated on an initiative to help prepare nurses for the mainstreaming of genomics into routine clinical care. Mainstreaming moves the application of genomics beyond rare diseases to also include risks factors and inheritance patterns for highly prevalent conditions such as cancer and cardiovascular diseases. An engagement framework was created using principles of nursing intraprofessional collaboration, the knowledge-to-action (KTA) cycle (Graham et al. 2006) and the diffusion of innovations theory (Rogers 2003). The engagement framework was used to determine key priorities for action and initial strategies to accelerate and sustain the integration of genomics into nursing practice in a Canadian context. The purpose of this article is to outline the key features of the engagement framework and describe how the framework can be used by leaders interested in preparing nurses for the mainstreaming of genomics into healthcare.

## Background

Genomics has improved the diagnosis and treatment of diseases such as cancer (Brittain et al. 2017; Peterson et al. 2019; Seed 2021) and cardiac disease (Khera et al. 2016; Pasipoularides 2018), and reduced healthcare costs and treatment burden for individuals (Bilkey et al. 2019; Stark et al. 2019). For example, the identification of BRCA gene variants for breast cancer or MSH2, MSH6 and MLH1 for colon and extracolonic cancers have resulted in screening programs and therapies that have changed the trajectory and outcomes of these diseases. Genomics provides insight into how early life experiences affect health and disease over one's lifespan and across generations (Letourneau et al. 2020, 2021; Merrill et al. 2021). Genomics is creating opportunities for health system transformation, including new or revised care pathways and patient engagement in health promotion and disease prevention. For example, reflex tumour testing (also referred to as somatic testing) for critical genetic aberrations is now observed across different types of cancer, including microsatellite instability testing in colorectal and endometrial cancers, which subsequently guides treatment decisions. The collection of a three-generation family health history remains an effective way to identify genetic risk and an opportunity to provide health education for screening and lifestyle

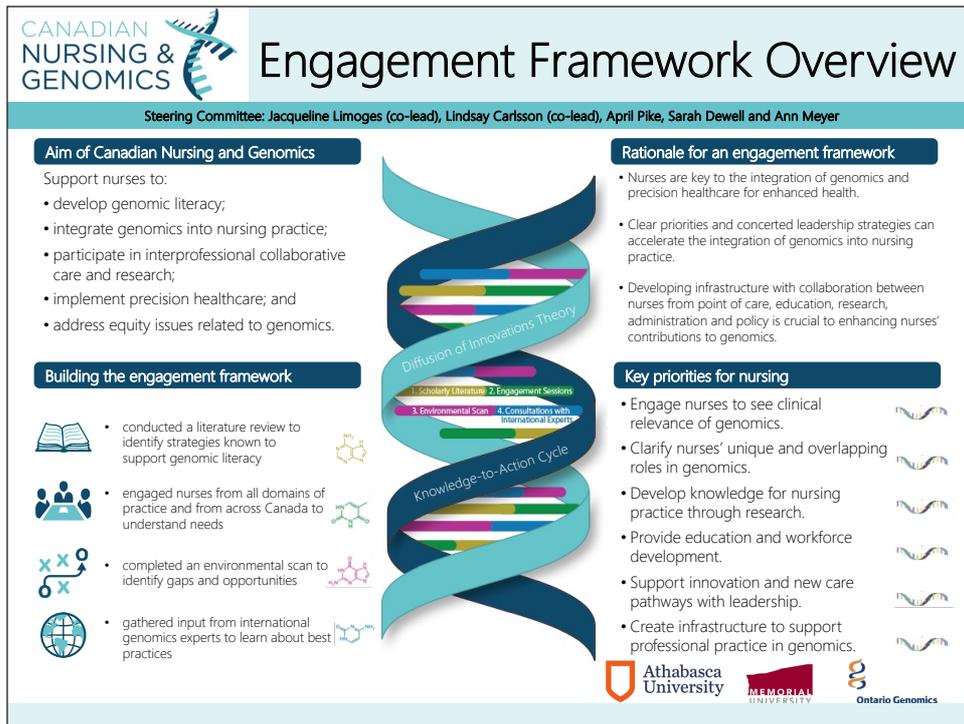
education associated with hypercholesterolaemia (Wilkinson et al. 2020). As such, it is imperative that nurses have the requisite knowledge and skills to provide genomics-informed care and to understand how genomics knowledge is linked to existing nursing knowledge and practices (Flowers et al. 2020).

There is significant interest among the general public in genetic testing and genomics (Etchegary et al. 2020), with many people participating in direct-to-consumer testing, such as “23andMe” (<https://www.23andme.com/en-ca/?fd=dr>), to learn more about themselves and their health risks. The COVID-19 pandemic has made genomics a topic of household conversation, with mainstream media reporting on genetic variants of the virus and their impacts on transmission and health outcomes. While there is interest in genomics, not surprisingly, people report variable preferences for learning about their genetic test results. For some, an identified genetic variant would trigger health-seeking behaviour, while others avoid genetic testing due to fear of the potential impact on their life (Manuel and Brunger 2014, 2015; Meiser et al. 2016; Mighton et al. 2019; Pollard et al. 2020). Individual preferences and decisions are informed by one’s personal characteristics and values, as well as contextual considerations, such as personal or family history of disease. Addressing genomics in nursing practice is increasingly important as genetic test results influence decisions about treatment options, which can impact health outcomes and experiences. Nurses with genomic literacy can provide education, recommend screening protocols and support lifestyle changes to empower patients to make informed decisions to reduce health risks (Peterson et al. 2019). Communication of genetic information within families is critical to ensure relatives are aware of their disease risk and thus important for nurses to support family communication in an effort to improve health outcomes.

Recognizing and understanding the ethical issues associated with genomics and genetic testing will support ethical practice. As many genetic conditions are inherited in families, personal decisions to have predictive genetic testing impact others for generations to come (Clift et al. 2019; Meiser et al. 2016; Pollard et al. 2020). Decisions around genetic testing can be influenced by concerns for discrimination, historical traumas and racial bias (Allen 2018; Bentley et al. 2017; de Mendoza et al. 2018). Although nurses’ disciplinary knowledge is housed in an ethical standpoint, they may not be fully aware of the complexities and discourses surrounding genomics to support these ethical and equity concerns. Equipped with genomic literacy, nurses can teach, make referrals to genetic counselling, create care pathways, conduct research, address ethical issues associated with genomics and advocate for equitable public policies. Supportive leadership and collaboration with other disciplines can help nurses to develop genomic literacy and gain confidence to engage in genomics-informed care and research (Calzone et al. 2018a; Tonkin et al. 2020b; Williams et al. 2017). An important first step in

Figure 1.

## Engagement framework overview



The authors acknowledge the contribution of Rebecca Puddester and the Canadian nurses who participated in virtual engagement sessions.

any leadership strategy is to understand nurses' needs and the practice context and to gather momentum. The following engagement framework can be a starting place for nurse leaders interested in assisting nurses to integrate genomics into practice.

### Method

An engagement framework was created to guide the initiatives of Canadian Nursing and Genomics (<https://www.nursingandgenomics.com/>) (see Figure 1 for the framework). The framework is centred on the premise that nursing intraprofessional collaboration across the five domains of practice (point of care, education, administration, research and policy) will support sustainable and evidence-based practice changes. Rogers' (2003) diffusion of innovations theory and the KTA cycle (Graham et al. 2006) created a structure and process for identifying knowledge/data sources and were used to identify nurses' priority needs. The KTA cycle includes two components: knowledge creation and an action cycle to guide knowledge translation and the implementation of interventions. The KTA cycle recommends engagement with knowledge users at every step to increase the uptake in practice. Once the engagement framework was established, it was

used to guide our approach to the initiative and propose strategies to accelerate the integration of genomics into nursing practice. We used the image of the DNA double helix and cell biology to create an analogy for our engagement framework (Figure 1). The strands of the DNA (the phosphate sugar backbones) are theories and frameworks that organize and orient our approach. The knowledge/data sources used to create the findings are represented by the four bases (adenine [A], cytosine [C], guanine [G] or thymine [T]). The priorities for action and recommendations for addressing the needs are represented in our framework through RNA transcription, the first step in gene expression. The framework ultimately leads to lasting “proteins,” which are the infrastructure and nursing interventions informed by genomics that support individual and population health.

Data sources included the scholarly literature, first-hand accounts from Canadian nurses, an environmental scan and consultation with international experts. To obtain the first-hand accounts of nurses, five engagement sessions were held, one for each domain of practice. Methodological and investigator triangulation where all authors were involved (Thorne 2016) during analysis of the four data sources support the trustworthiness, credibility and reliability of the findings. When there was discrepancy or uncertainty, the team would return to the sources of data until consensus was achieved. The recommendations to support addressing the six identified priorities are informed by the data sources within the framework, including the collective experience of the Canadian Nursing and Genomics (CNG) Steering Committee.

## Identifying the Priority Needs Associated with Nursing and Genomics

### *Literature review*

Literature was explored to understand needs associated with the development of genomic literacy in nurses. Electronic databases, including the Cumulative Index of Nursing and Allied Health Literature (CINAHL) and Google Scholar, were searched using the terms “nurs\*” with combinations of AND “genomics,” “precision health” and “genetics.” Additionally, the ancestry and descendancy approaches, as described by Polit and Beck (2017), were used. The following text summarizes two key findings from the literature review.

#### *1. The need for education to address genomic literacy*

Globally, the low genomic literacy levels of faculty, health administrators, nursing educators and point-of-care nurses is cited as a key barrier to the integration of genomics into nursing education (Bashore et al. 2018; Camak 2016; Daack-Hirsch et al. 2011; Jenkins and Calzone 2014; Wright et al. 2019). Specifically in Canada, there is sparse literature on this topic, but two studies (Bottorff et al. 2005b; Dewell et al. 2020a) reported low genomic literacy rates in nurses, nursing

students and nurse educators, suggesting that Canada is in a similar situation to other countries. Increasing the levels of genomic literacy is important as faculty who understand the importance of genomic literacy and genomics-informed nursing practice are motivated to make room for genetics and genomics in their courses and curriculum (Daack-Hirsch et al. 2012; Fangonil-Gagalang and Schultz 2021; Jenkins and Calzone 2014). Similarly, administrators who understand the potential of genomics to improve patient care support new care pathways using genomics (Calzone et al. 2018a). Therefore, education at all levels, from entry to practice to continuing education is a key strategy to accelerate the adoption of genomics (Dagan et al. 2021; Zimani et al. 2021).

## *2. Collaboration*

Collaboration between healthcare providers and educators is critical to the development of infrastructure that supports genomics practice such as policies, practice guidelines and mentorship (Calzone et al. 2018b; Tonkin et al. 2020b). Collaboration can lead to identifying early adopters and opinion leaders in genetics and accelerate uptake of genomics into nursing practice (Graham et al. 2006; Leach et al. 2016). Pairing education with opportunities to integrate knowledge into clinical practice can assist nurses in retaining knowledge of genomics (Calzone et al. 2018a; Dagan et al. 2021). The Faculty Champions Project in the US demonstrated how structured collaboration between sectors promoted consistent inclusion of genomics into nursing curriculum (Jenkins and Calzone 2014). These studies highlight the importance of creating educational and clinical programs in concert, and with purposeful knowledge mobilization strategies.

## *Engagement sessions*

Virtual engagement events were held between March and May 2021, with 27 nurses from across Canada. Participants were recruited through the professional networks of the steering committee members, as well as by indexing websites of schools of nursing, professional associations and nursing regulatory bodies. Nurses who expressed interest in attending an engagement session were included, and none were excluded. See Table 1 for distribution of participants by province and domain of practice. The objectives of the engagement events were to (a) learn about Canadian nurses' experiences with genetics and genomics, (b) identify and explore strategies to support the further integration of genetics and genomics into nursing practice and (c) identify barriers and facilitators to integrating genetics and genomics into nursing practice. Nurses were invited to attend a session that best reflected their domain of practice. Sessions were facilitated by the CNG Steering Committee, and notes were taken. The notes were analyzed for themes using thematic analysis (Braun and Clarke 2006) and an iterative approach until consensus was achieved on the key themes. Nurses identified four areas for development that would enhance genomic literacy and the integration of genomics into nursing practice:

- Raise awareness of the intersection between nursing practice and genomics for safe, ethical and compassionate nursing care to motivate nurses to engage in learning and practice changes.
- Provide role clarity and define required knowledge that would enable nurses to practise interprofessionally and make impactful and socially just contributions to healthcare informed by genomics and precision healthcare.
- Conduct research to answer clinical questions associated with the integration of genomics into nursing practice and education.
- Foster leadership to support inter- and intraprofessional collaboration that addresses barriers and enablers to participation in genomics and precision healthcare. Leadership is also needed to develop infrastructure such as entry-to-practice competencies and minimal nursing competencies, practice guidelines and policies to clarify expectations for genomic literacy.

<b>Table 1.</b>		<b>Participants in engagement sessions</b>
<b>Domain</b>	<b>Province</b>	
Administration ( <i>n</i> = 3)	Newfoundland and Labrador ( <i>n</i> = 1), Manitoba ( <i>n</i> = 1), Ontario ( <i>n</i> = 1)	
Research ( <i>n</i> = 6)	Alberta ( <i>n</i> = 2), British Columbia ( <i>n</i> = 1), Ontario ( <i>n</i> = 2), Prince Edward Island ( <i>n</i> = 1)	
Education ( <i>n</i> = 7)	British Columbia ( <i>n</i> = 1), New Brunswick ( <i>n</i> = 1), Newfoundland and Labrador ( <i>n</i> = 2), Ontario ( <i>n</i> = 2), Nova Scotia ( <i>n</i> = 1)	
Policy ( <i>n</i> = 3)	Alberta ( <i>n</i> = 1), New Brunswick ( <i>n</i> = 1), Quebec ( <i>n</i> = 1)	
Point-of-care nurses ( <i>n</i> = 8)	Alberta ( <i>n</i> = 1), British Columbia ( <i>n</i> = 1), Manitoba ( <i>n</i> = 1), Newfoundland and Labrador ( <i>n</i> = 1), Ontario ( <i>n</i> = 2), Prince Edward Island ( <i>n</i> = 1), Saskatchewan ( <i>n</i> = 1)	

Nurses in the five domains of practice were consistent in identifying the four areas for development, although there were slight differences in how this would unfold depending on the domain. For example, nurses in the education domain identified role clarity as a need so that they could effectively teach about genomics-informed care, whereas nurses from point of care needed role clarity to support clinical decision making. These four areas for development were then considered with the other sources of knowledge (literature, environmental scan and consultations with experts).

### *Environmental scan*

To identify infrastructure, resources and gaps, an environmental scan was conducted during July and August of 2021. Canadian websites and website documents of provincial nursing regulatory bodies and professional nursing associations (e.g., Canadian Association of Schools of Nursing, Canadian Nurses Association and Canadian nursing specialty groups) were scanned for content that

included the words “genetic(s)” and/or “genomic(s).” The Assessment of Strategies to Integrate Genomics in Nursing (ASIGN) tool (Tonkin et al. 2020a) was used to evaluate the results of the search. The ASIGN tool includes six critical success factors known to support the integration of genomics: (1) enhanced education and workforce development, (2) effective nursing and midwifery practice, (3) sustainable infrastructure and resources, (4) collaboration and communication, (5) public and patient involvement and (6) healthcare transformed through leadership and strategy. The Global Genomics Nurses Alliance (G2NA) developed the ASIGN tool to assist leaders to evaluate the micro, meso and macro context and to assess their situation along a continuum of the maturity matrix (Tonkin et al. 2020a).

Findings revealed a lack of infrastructure such as genomic nursing competencies or practice standards, formal role descriptions, education requirements, or leadership for genomics housed within existing professional or regulatory organizations. As a country, Canada is in the very early stage of integrating genomics into nursing as most of the six critical success factors in the ASIGN tool have yet to be implemented in Canada. There is a notable gap between the infrastructure in Canada and countries that are successfully integrating genomics into nursing practice (e.g., the US and the UK). Despite this, Canada does have some enablers to support nursing and genomics, which can be leveraged. For example, there is representation from Canada in the G2NA and the International Society of Nurses in Genetics (ISONG), and strong international relationships exist between members of the CNG and leading experts in other countries.

### *Expert opinion*

As the integration of genomics is a global nursing challenge, there is strong support within the international community for knowledge sharing. Knowledge mobilization between countries will optimize the accessibility of resources, reduce duplication of efforts and support collaboration among high-, medium- and low-income countries to support global nursing health initiatives (Calzone et al. 2018b). Additionally, the G2NA is in the process of developing minimum global genomic competencies for nurses. Therefore, aligning the Canadian efforts with the global movement was viewed as productive. Consultations with nurses working in the field of genomics assisted us in learning from their experience and making practical recommendations for addressing the needs of Canadian nurses.

### **Findings**

The approach outlined in the engagement framework (Figure 1) was used to identify priority needs associated with nursing and genomics and to develop the findings. Through analysis of the literature, engagement sessions with nurses, environmental scan and consultation with experts in nursing and genomics, six key

priority needs were identified. Recommendations on how to use the framework and to stimulate leadership strategies to address the needs are identified:

1. *Engage nurses to see clinical relevance of genomics that will support buy-in:* When nurses understand the contributions of genomic literacy to patient outcomes, and how routine practices such as collecting a family health history, health education and emotional support can be augmented by genomic literacy, interest will grow. Rogers' (2003) diffusion of innovations theory is useful for understanding how new ideas and clinical innovations spread within and across organizations. Rogers highlighted the importance of considering the individuals involved in the adoption process and their readiness for new ideas. Identifying early adopters, often those who already see the clinical utility of ideas and understand the potential for the idea to generate positive impact, can be a useful initial step. Early adopters can engage others and provide insight on strategies that would accelerate the integration of genomics. With this in mind, leaders can use early adopters to create shifts in acceptance and interest in knowledge integration. Rogers' (2003) theory was successfully used in this way to advance nursing practice in genomics (Andrews et al. 2014; Dewell et al. 2021).
2. *Clarify nurses' unique and overlapping role in genomics to improve population health outcomes, enhance patient experience, increase provider satisfaction and offer better value for cost:* Role clarity in genomics-informed nursing care was raised as an issue in Canada (Bottorff et al. 2005a; Dewell et al. 2021) and is identified as a key enabler for professional practice (Tonkin et al. 2020a). Role clarity has challenged nurses for decades (Almost 2021). Until nursing research specific to genomics-informed nursing care is conducted, general strategies that support role clarity such as inter- and intraprofessional education and collaboration during the design of care pathways are recommended (Lankshear and Limoges 2021). These strategies can be used to assist nurses in clarifying their role in genomics and precision healthcare.
3. *Develop the workforce through education and clinical learning to ensure nurses have genomic literacy and skills to participate in genomics-informed care:* Nurses require foundational knowledge in genomics and guidance on how to apply this knowledge in practice (Dagan et al. 2021; Dewell et al. 2020b). Collaboration among nurses from the five domains of practice will support the development of sustainable and impactful education by creating evidence-based content for education and opportunities to apply this knowledge in clinical care. The importance of opportunities to participate in and observe nursing practice that includes genomics is crucial to knowledge retention (Dagan et al. 2021).

Addressing structural barriers, such as lack of time and difficulty finding relevant education resources, can support nurses to learn foundational knowledge in genomics (Saleh et al. 2019). This is of particular importance, given nurses' high workloads amid the COVID-19 pandemic. The Genomic Nursing Concept Inventory (Ward et al. 2014) is a validated tool for measuring the impact of education strategies and assessing levels of genomic literacy and is widely used to measure the outcomes of education (Dewell et al. 2020a; Dumo et al. 2020; Read and Ward 2016; Wright et al. 2019). The Genetics and Genomics Nursing Practice Survey is a validated tool to measure registered nurses' competency, attitudes, confidence and decisions to adopt genomics into practice (Plavskin et al. 2019). Educators can use either of these tools to conduct pre- and post-tests to determine the effectiveness of education interventions and how the education is influencing practice.

Engaging in dialogue to assist nurses in navigating the ethically complex challenges of genomics (Walker et al. 2020) can enable nurses to find meaningful ways to integrate genomics into existing practice frameworks. Dealing with the ethical issues that are inherent to genomics, such as privacy and discrimination, will assist nurses in addressing social justice, equity and ethical concerns. Linking education to professional practice documents such as the International Council of Nurses's *Code of Ethics*, which now includes specific requirements associated with genomic literacy (ICN 2021), can enable nurses to align to the ethical duties within genomic healthcare.

4. *Promote innovation and new/revised care pathways that include genomics:* Recognizing that nurses will require guidance to make changes in their practice will prompt intentional and concerted leadership strategies. Global organizations including ISONG and G2NA have resources to advance genomic nursing knowledge and practice. G2NA's ASIGN tool can be used by leaders in professional and healthcare organizations to identify gaps and priorities within their specific context. The G2NA also developed a roadmap for strategic activity to accelerate the integration of genomics across nursing (Tonkin et al. 2020b). The G2NA, ISONG, ASIGN tool and roadmap enable collaboration, benchmarking and networking to accelerate the adoption of genomics. The newly created clinical and leadership roles for nurses in the ongoing roll-out of Genomic Medicine Services Alliance across England (NHS 2020) can provide inspiration to nurse leaders.
5. *Develop infrastructure to support professional practice in genomics, including curriculum, practice standards, policies and procedures and inter- and intraprofessional collaboration:* To enable effective teamwork and system-wide changes, leaders need to address the complex social process involved

in collaboration. Carefully designed strategies can support collaboration, advocacy and clinical innovations to tackle present and future healthcare challenges (Lankshear and Limoges 2021; Limoges and Jagos 2016). Nursing intraprofessional collaboration can support the development of policies, procedures, curricula and standards of practice. Infrastructure, including research funding, undergraduate and graduate programs with courses and assignments in genomics and research mentorship will enable made-in-Canada support for nursing practice in genomics.

6. *Advance research to develop knowledge and clinical interventions for nursing practice:* Creating evidence to support nursing practice is crucial to safe and competent nursing care and to ensure that the benefits of genomics reach patients. The KTA cycle (Graham et al. 2006) offers a model to identify priorities, barriers, enablers and strategies to support knowledge production and mobilization. The KTA endorses collaboration between researchers and knowledge users to advance the understanding of the factors that facilitate or impede the development and uptake of knowledge. Gathering nurse experts around a specific and symptom-focused topic is an effective strategy to promote research in genomics (Hickey et al. 2019). Using the KTA cycle and a patient-oriented approach to knowledge construction will help ensure that inequities in care are addressed, scientific discoveries are contextualized and informed decision making unfolds. Within Canada, nursing researchers have started this important work. For example, Letourneau et al. (2020) demonstrated the interaction between the index score of plasticity genes and parental unresponsiveness in predicting outcomes of aggression and inattention in children. These findings are pertinent to family nursing practice when designing interventions to support parenting and child development. Manuel and Brunger (2014) captured the experiences of individuals living in a family at-risk for arrhythmogenic right ventricular cardiomyopathy as they make the decision to have predictive genetic testing. This type of research provides nurses with knowledge on the lived experience of decisions around genetic testing and living with a known genetic variant, which can inform practice.

## Discussion

After recognizing the need to develop the healthcare workforce and health system for the integration of genomics, many countries (e.g., the UK, the US, Finland and Israel) made significant investments in education and infrastructure (Stark et al. 2019). In these countries, nurses participate in the design and delivery of new care pathways, interprofessional research and practice and advocate for equitable access to genetic resources. These successes demonstrate the value of leadership and the contributions of nurses to genomics and precision healthcare. Canada has not yet made similar investments, and as such, we are lagging behind countries,

most notably the UK. However, nurses in positions of influence, who are early adopters of genomics, or who see the clinical utility of genomics, can provide leadership (Leach et al. 2016). All nurses are capable of providing leadership, and a first step is to develop a basic understanding of the potential of genomics to inform care and create interest and motivation for change. The CNG initiative and engagement framework and organizations such as the G2NA offer support and guidance to nurse leaders.

As genomics and precision health become part of routine healthcare (Feero 2017), nurses must be aware of the ethical, legal, social and scientific issues concerning genomics to promote health outcomes. Nurse leaders who are interested in accelerating the adoption of genomics into practice can use the six identified priorities for action and the engagement framework designed by the CNG to structure their strategies. The engagement framework includes nursing intraprofessional collaboration and strategies informed by Rogers' (2003) diffusion of innovations theory and the KTA cycle (Graham et al. 2006). Leaders are encouraged to work with the engagement framework to determine the priorities and opportunities within their own context to mobilize the interest and resources within their setting/team.

Accelerating the integration of genomics into practice will enable nurses to fully participate in the creation of care pathways, education and research. Canadians have unique equity issues, particularly among Canadian Indigenous populations, that must be understood and addressed during efforts to integrate genomics into healthcare (Haring et al. 2021; Hudson et al. 2020). Creating made-in-Canada innovations that are developed through engagement and collaboration with diverse populations will ensure that nurses have strategies that reflect the Canadian education and healthcare context. Consideration of genomics by nurses in all five domains of practice can help address inequities and ethical issues associated with genomics, such as access to genetic testing, consideration of the social determinants of health and genomics and low representation of ethnic and minority groups in genomics research. Nurses from all domains of practice need to work collaboratively to develop knowledge for practice, educate nurses and develop strategies and policies to advance nursing practice in genomics.

## **Conclusion**

Nurses are well-positioned in the health and education system to use genomic literacy to improve health outcomes. Canadians will benefit from strong leadership that supports nurses to integrate genomics into practice. Nurses in all domains of practice can integrate genomics into existing nursing knowledge and practice to enhance patient care. The engagement framework, founded in intraprofessional collaboration, diffusion of innovations theory and the KTA cycle

can evolve as the six key priorities for action are addressed and as new genomics knowledge and clinical applications arise.

Made-in-Canada knowledge and leadership strategies are required to ensure that nurses participate in genomics-informed practice. Nurses with genomic literacy can address the equity and ethical issues associated with genetic testing and genomics to promote health for all. Research is required to understand nurses' current level of genomic literacy, attitudes toward genomics and engagement strategies that motivate learning and practice changes. Research is also required to test the utility of leadership strategies and to evaluate the impact of nurses' genomic literacy on patient outcomes. As genomics discoveries, nursing interventions and clinical pathways are developed, population-level studies can further clarify the potential of genomics. Returning to the analogy that we used to create the engagement framework (molecules, DNA and RNA) – as more knowledge on genomics, nursing practice and patient needs emerge – the knowledge sources (bases) reconfigure to generate new messenger RNA and thus new needs and strategies. In this way, the engagement framework can continue to evolve and support nursing practice in genomics. Canadian nurses can and should provide leadership in genomics-informed nursing practice and contribute to the global initiatives in genomics aimed at improving health outcomes. Nurses in Canada and elsewhere are invited to collaborate with the CNG (<https://www.nursingandgenomics.com/>) to engage in the research described in this article and to explore strategies that support nurses in genomics-informed care.

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