Exploring Canadian Genetic Healthcare Providers' Perspectives on Sponsored Genetic Testing

by

Piruze-Daena Hirjikaka

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ABSTRACT

Sponsored genetic testing (SGT) programs consist of partnerships between clinical genetic testing laboratories and third-party organizations (generally biopharmaceutical companies) to offer genetic testing free of charge to a patient or healthcare system. To date, there is no research surrounding the use of SGT in Canada, or how it is perceived by professionals.

This study aims to learn about Canadian genetic healthcare providers' (CGHPs') views on SGT, along with their perceived benefits, limitations, and impacts of SGT within the Canadian healthcare system.

Certified genetic counsellors, medical geneticists, and laboratory geneticists practicing in Canada were invited to participate in semi-structed interviews. Interviews were recorded over Zoom, transcribed verbatim, and analyzed using interpretive description and thematic analysis. Codes were created inductively, and themes emerged across cases to capture participants' perceptions.

Interviews were conducted with 18 CGHPs across six provinces. Some participants were ambivalent about SGT, and others either agreed or disagreed with its use in practice. Perspectives were categorized into four main themes: 1) adequate transparency surrounding data sharing 2) the desire for a workaround to improve access 3) consideration of budgets within a publicly funded healthcare system and 4) perspectives of non-genetics providers using SGT. Proponents noted that transparency regarding data sharing between the genetic testing laboratories and third-party companies was adequate, that SGT could provide increased access to genetic testing, and that SGT can help advocate for enhanced provincial funding of genetic services. Skeptics of SGT mentioned a lack of transparency regarding how patient data is shared and used, that a public system should be able to cover all patients who require genetic testing, and that there is a responsibility to consider how externally funded testing could be detrimental to future budget considerations. All participants had considerations for their non-genetics colleagues ordering SGT.

This exploratory study offers insights surrounding CGHPs' views on SGT. It highlights the benefits and limitations regarding the use of SGT in Canada, along with a unique perspective into the challenges and nuances of using SGT within a publicly funded healthcare system.

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LIST OF ABBREVIATIONS

ABGC: American Board of Genetic Counselors

ACMG: American College of Medical Genetics and Genomics

B: Benign

CAGC: Canadian Association of Genetic Counsellors

CCMG: Canadian College of Medical Geneticists

DTC: Direct to Consumer Testing

CGHPs: Canadian Genetic Healthcare Providers

E2P2: Education, Ethics and Public Policy

GI&P Genetic Information and Privacy Working Group

HCPs: Healthcare providers

HIPAA: Health Insurance Portability and Accountability Act

LB: Likely Benign

LP: Likely Pathogenic

NHS: National Health Service

NGS: Next Generation Sequencing

P: Pathogenic

PHIA: Personal Health Information Act

PHIPA: Personal Health Information Protection Act

SGT: Sponsored Genetic Testing

UK: United Kingdom

USA: United States of America

VUS: Variant of Uncertain Significance

CHAPTER 1: BACKGROUND INFORMATION

1.1 Introduction

The first section of this chapter introduces the topic being addressed by this study. It is followed by an introduction to genetics and genetic testing, and an investigation surrounding the genetic services offered across Canada. This section is followed by information on the genetic counselling process and subsequently, there is a description of sponsored genetic testing (SGT) and a review of relevant published literature. This chapter ends with the study's rationale and research question.

1.2 Statement of the Problem

Genetic testing holds the ability to provide diagnostic information for patients with symptoms suspected to be caused by a genetic disease. Genetic testing may inform healthcare decisions and management for patients. Within Canada, genetic testing is funded by provincial healthcare ministries, and generally offered to patients by their healthcare providers, particularly, genetic specialists (Christian et al., 2015). SGT refers to genetic testing offered in partnership between a genetic testing laboratory and a third-party company (typically a pharmaceutical company) (Larson et al., 2023). The third-party company funds the monetary cost of the test, circumventing the need for a public healthcare system, an insurance company or a patient, to provide compensation (Bartels et al., 2024).

There is an increasing availability of SGT for Canadian healthcare providers to avail of, which has resulted in an increased use; however, the specifics of uptake are unknown. Concerns have been raised surrounding this alternate avenue of genetic testing. Firstly, there are concerns regarding

genetic data sharing and patient privacy stipulations between the genetic testing laboratory and third-party pharmaceutical companies in SGT programs (Larson et al., 2023). Secondly, there are concerns about potential downstream impacts on provisions of public funds allocated to Canadian genetics programs as a result of this 'no-cost' alternative option (Bartels et al., 2024) Thirdly, there are concerns about physicians not trained in genetics ordering SGT, and questions surrounding whether patients are providing informed consent for the test (Bartels et al., 2024).

Currently, little is known about the actual benefits, or implications of SGT in Canada. Understanding SGT from the perspective of Canadian genetic healthcare providers (CGHPs) who are well versed in the practice of genetics and appreciate the nuances of genetic testing within the Canadian context, will help recognize the potential benefits and implications of introducing this pathway of genetic testing into practice.

1.3 Introduction to Genetics

The practice of genomic medicine has infiltrated almost all health specialties. There are approximately 10,000 monogenic conditions known to date, these are defined as inherited conditions arising from genetic variations in a single gene (Konishi & Long, 2020). While many individual genetic conditions may not be common, it is estimated that 6% of individuals will be affected by a genetic disorder at some point in their life (Rodwell & Aymé, 2014). Today, the practices of oncology, cardiology, neurology, pediatrics, fetal medicine, and countless other specialties rely on genetic information to best care for patients. For example, genetics is at the forefront of rare disease care. There are an estimated 6,000–7,000 rare diseases, with approximately 80% being of genetic origin (Brittain et al., 2017; Haendel et al., 2020). While an

individual rare disease is categorized as impacting less than 1 in 2,000 individuals, when put together, rare diseases impact many (Brittain et al., 2017).

In the oncology space, germline and somatic genetic sequencing has allowed for personalized care of patients. Approximately 10% of cancers are thought to have monogenic etiologies associated with hereditary cancer syndromes (Van Cott, 2020). The inclusion of genetic testing in oncology has helped provide targeted management guidelines based on cancer genotype, including recommendations for early intervention and prevention, along with risk estimates for biological family members (Kurian et al., 2018).

As the field of genetics evolves, more isolated and syndromic causes of cardiovascular conditions are being understood. For inherited aortopathies, cardiomyopathies, and arrythmias, amongst others, the identification of monogenic origins can allow for early interventions such as implantable cardiac devices, or more frequent monitoring through echocardiograms as preventive measures, and subsequently, improved patient outcomes (Corrado et al., 2021).

In the field of neurology, early onset cognitive disorders, or movement disorders can be diagnosed, or confirmed, through genetic testing (Salunkhe et al., 2022). The prevalence of genetic influences in neurology is not surprising, as 80% of genes have active expression in the brain, and 40% of known genetic disorders impact the central nervous system (Salunkhe et al., 2022).

As such, it is clear that genomic knowledge and genetic testing is being incorporated into patient care across all disciplines.

1.3.1 Introduction to Genetic Testing

A genetic test is typically done in a laboratory, where an individual's genes are sequenced and compared to a reference. A genetic test for monogenic conditions tries to identify changes or variants in a person's genome, which may change how that gene product functions (Richards et al., 2015). Genetic testing is conducted since it can improve health outcomes and quality of life for patients and their families (Funanage, 2021). Genetic testing for monogenic conditions not only provides answers for patients and families, but also guides management and prevention by informing healthcare providers on how to offer the best care to their patients (Funanage, 2021). Genetic testing can provide answers for those undergoing a diagnostic odyssey or inform individuals if they are at increased risk for certain conditions (Funanage, 2021).

Knowledge in the field of genetics continues to grow rapidly. The introduction of next generation sequencing (NGS) has both increased the availability of genetic testing and decreased its cost (Wetterstrand, 2015). As of November 2022, an estimate of 197,779 genetic tests were available globally, with over 90% of tests being for clinical purposes (Halbisen & Lu, 2023). Next Generation Sequencing (NGS) allows for the ability to test hundreds or thousands of genes simultaneously, and this advanced technology has made gene panels (testing multiple genes) more economical and efficient (Bean et al., 2020; McCombie et al., 2019).

1.3.2 Variant Interpretation

NGS has helped grow the rate at which genetic testing can be conducted. As more genes are tested, more genetic variants are identified. The challenge with variants is understanding the impact of these variations on patient care. To aid in the classification of genetic variation, the

American College of Medical Genetics and Genomics (ACMG) and the Association for Molecular Pathology developed a variant classification system to facilitate consistent application of evidence-based criteria. This system categorizes variants into 5 classes: benign (B), likely benign (LB), variant of uncertain significance (VUS), likely pathogenic (LP), or pathogenic (P) (Richards et al., 2015). This reporting system allows for certain criteria to be met for each variant to accurately classify it within one of these categories, allowing clinicians to understand whether a genetic variant may be significant in the health of their patient (Richards et al., 2015). Medical management is generally not altered based on benign and likely benign variants, with most laboratories not reporting these variants. Likely pathogenic and pathogenic variants are considered to change the function of the gene and may be the cause of patients' health concerns or indicate an increased risk for the condition associated with the gene in question (Richards et al., 2015). VUS are variants where there is insufficient evidence to classify the variant in the other 4 classes. As such, a VUS should not be used to change medical management (Richards et al., 2015). Overtime, other studies including segregation analysis, or functional studies may help reclassify a VUS (Caputo et al., 2021). In a recent study assessing a cohort of approximately 1.6 million individuals who underwent genetic testing, 41% of individuals had a VUS. Overtime, approximately 80% of the VUS were downgraded to B/LB (Chen et al., 2023).

1.4 Process of Genetic Testing

Reasons for why individuals may be offered a genetic test in a healthcare setting include the medical presentation, the clinician's judgment on the likelihood that a patient has a genetic condition, clinical utility, cost of the test and more (Christian et al., 2015; Weymann et al., 2022). Medical presentation and clinical judgment are important to help providers narrow down which

genes may be responsible for a patient's presentation and guide which set of genes should be tested (National Academy of Sciences et al., 2017). The clinical utility of a test is the value or impact a test will have on the patient's health care and management decisions (Teutsch et al., 2009). The cost of a test is taken into consideration when there is a set budget within a health system for ordering genetic tests (National Academy of Sciences et al., 2017). In general, genetic tests can help prevent individuals with undiagnosed conditions from undergoing further testing and help physicians tailor health management recommendations.

1.4.1 Genetic Testing Allocations in Canada

Genetic testing is offered by healthcare providers to patients with a suspected diagnosis or family history of an inherited condition. Each province has its own clinical criteria and process for ordering a genetic test (Alberta Health Services, 2022; Husereau et al., 2023; Ontario Ministry of Health, 2022). Very specialized or large genetic testing panels have usually been limited or restricted to medical geneticists and genetic counsellors (Lambert et al., 2022).

1.4.2 Genetic Laboratories in Canada

Genetic clinics and laboratories across Canada require each provinces' healthcare system to organize and structure institutions based on resource availability (Husereau et al., 2023). Most hospitals in Canada are independent, non-profit entities that receive annual stipends from the provincial government, and may be supported by federal governments (Husereau et al., 2022). Federal law states that hospitals provide medically necessary diagnostic testing and interpretations, which includes genetic diagnostics such as cytogenic and molecular testing (Husereau et al., 2022). Within the Canadian context, laboratories delivering these diagnostic services tend to be concentrated in specialized tertiary care centres which may also rely on

funding from other sources such as academic centres or donations (Husereau et al., 2022). Coordinating service delivery tends to be less challenging in smaller provinces with limited public health laboratories. This is in contrast to larger provinces with multiple centres and catchment areas, which are challenged by decentralized service delivery (Lilley et al., 2013).

Regardless of province, genomics laboratories face challenges across the country (Christian et al., 2015). Challenges include the delivery of genetic testing to patients, and laboratory diagnostics keeping up with the fast-moving landscape of genomics. These challenges can be due to limited financial resources, such as obtaining funding for new testing equipment, or lack of people resources to facilitate validation of instruments (Husereau et al., 2022).

In all provincial genetic laboratories, some genetic tests are conducted 'in-house' where the genetic test is performed at a local laboratory, whereas other genetic tests are sent to various laboratories across Canada or other countries such as the United States of America (Ministry of Health Provincial Health Services Authority, 2021).

1.4.3 Provincial Differences in Genetics Readiness

As genetics services are designed specific to each jurisdiction and province, there are differences between provincial practices. Some provinces are taking larger steps toward the improvement of genetics services, whereas others are still overcoming considerable hurdles, putting certain provinces in a better position for readiness of the genomic medicine era (Husereau et al., 2023). Genetic testing is context-dependent — testing relies on referral patterns, education and training of healthcare providers, and potential intervention for the genetic condition in question. In Ontario, genetic testing in 2016 represented only 0.2% of all healthcare costs (Office of the

Auditor General of Ontario, 2017) and this relatively small expenditure may play a role into the lack of motivation for healthcare administrators to invest in genomics (Husereau et al., 2023).

In an assessment of genetic health systems in Alberta, Quebec, Ontario, British Columbia, and Nova Scotia, strengths and weaknesses were seen across all provinces (Husereau et al., 2023). Provinces with single service organizations, or linked laboratory systems were noted as having strengths in their ability to provide resources and oversight for all genetic testing, along with cost savings (Lilley et al., 2013). This was noted with the Alberta Precision Laboratories, and Direction de la biovigilance et de la biologie médicale in Quebec (Husereau et al., 2023). This study suggested that some shared weaknesses between provinces included the need for province-wide regulation for how to implement new tests, and engagement of stakeholders like patients and providers (Husereau et al., 2023).

Smaller provinces such as Nova Scotia may be able to achieve a higher level of coordination because of lower service demand and the ability for the government to coordinate directly with the individual hospitals which provide genetic testing (Husereau et al., 2023). However, in Ontario, this may be a greater challenge due to higher service volumes, a larger volume of tertiary care centres offering genetics services, and until recently, a decentralized health system (Husereau et al., 2023). Centralization of healthcare systems in Alberta is thought to provide a logistical benefit to patients and providers, and also includes a single point of entry for any new testing, making review processes and integrations less complex (Lilley et al., 2013).

Similarly, Saskatchewan also directs all external genetic testing through a genetics resource centre (Saskatchewan Health Authority, 2022a) This centre was created to manage genetic test orders

for laboratories outside of the province or country and to support the education of healthcare providers ordering the test.

The table below demonstrates differences between provincial jurisdictions across Canada regarding approval processes for send-out genetic testing, including who reviews requests, whether genetic testing is restricted to only clinical genetics, and whether there is a formal application (Christian et al., 2015). This table is from a publication in 2014 and as such, some processes may have changed since then.

Table 1: Differences between Provincial Jurisdictions for genetic testing send-out processes © S. Christian et al., 2014. Used with permission from John Wiley and Sons.

Jurisdiction	Approval body	Requests restricted to clinical genetics?	Request reviewed by a genetics specialist?	Formal application?	Review process
BC	Ministry	Yes	No	Yes	Individual
BC (hereditary cancer)	Clinic	Yes	Yes	No	Committee
AB	Lab	No	Yes	Yes	Multiple
SK	Clinic	Yes	Yes	No	Individual
MB	Lab	No	Yes	Yes	Committee
ON	Ministry	No	Yes	Yes	Multiple
QC	Clinic	No	Yes	Yes	Individual
NS and PEI	Lab	No	Yes	Yes	Committee
NF	Lab	Yes	Yes	No	Individual
NB (out of province)	Ministry	No	No	No	Individual
NB (in province)	Lab	No	No	No	Individual
YK	Ministry	No	No	Yes	Individual
NT	Ministry	No	No	Yes	Individual
NU	Ministry	No	No	Yes	Individual

AB, Alberta; BC, British Columbia; MB, Manitoba; NB, New Brunswick; NS, Nova Scotia; NT, Northwest Territories; NU, Nunavut; ON, Ontario; PEI, Prince Edward Island; QC, Quebec; SK, Saskatchewan; YK, Yukon.

This publication demonstrates that each provincial system has developed their own approach, which may include restricting genetic testing to geneticists as experts to ensure patients with the highest disease suspicion are appropriately tested and cared for (Christian et al., 2015).

1.4.4 Laboratories' Approaches to Navigating Development of NGS Gene Panels

Curation of a genetic test to diagnose a genetic condition uses a phenotype-directed review of disease-causing genes and expertly published guidelines. Curation of a genetic test refers to the

careful selection of genes to create a panel. Guidelines are informed by research which has evaluated aspects such as clinical utility, test appropriateness, minimal clinical burden such as rates of VUS, and benefit to the patient (Bean et al., 2020). Laboratories are also encouraged to report the test sensitivity of various types of genetic variants, such as the test's ability to identify repeat expansions, single nucleotide variants or larger structural anomalies (Bean et al., 2020). Certain genes or gene regions may not be analyzed due to technical challenges intrinsic to a gene or testing methodology, and this information should be available in the test description (Bean et al., 2020). This allows providers such as genetic counsellors, medical geneticists, and laboratory scientists to determine whether the use of a certain gene panel is appropriate to assess a patient's symptoms. Assessing and scrutinizing genetic panels is a key skill in which genetics healthcare professionals receive training. There are multiple clinical testing laboratories, for profit, non-profit, and academic centres which offer gene panels to test for the same medical condition; however, genes included on panels to test for the same condition are not standardized and can vary greatly between laboratories (Bean et al., 2020). The example below (table 2) was gathered from four recognized testing laboratories' websites for genes included in a genetic test for the same condition—craniosynostosis.

Table 2: Comparison of Genes Offered on NGS Panels for the Same Indication Across Laboratories

Laboratory	**Number of genes on panel and list of genes**
Laboratory 1	**(5)** FGFR1, FGFR2, FGFR3, TCF12, TWIST1
Laboratory 2	**(30)** ALPL, ALX4, ASXL1, CDC45, CYP26B1, EFNB1, ERF, FGFR1, FGFR2, FGFR3, GLI3, IFT122, IFT43, IL11RA, MASP1, MEGF8, MSX2, P4HB, POR, RAB23, RECQL4, SEC24D, SKI, TCF12, TGFBR1, TGFBR2, TMCO1, TWIST1, WDR35, ZIC1
Laboratory 3	**(38)** ALPL, ALX3, ALX4, BMP4, CDC45, EDNRB, EFNB1, ERF, ESCO2, FGFR1, FGFR2, FGFR3, FLNB, FREM1, GDF5, GLI3, IFT122, IFT140, IL11RA, MASP1,

	MEGF8, MSX2, NOG, PAX3, POR, RAB23, RECQL4, SKI, SOX10, SPECC1L, TCF12, TGFBR1, TGFBR2, TWIST1, TWIST2, WDR19, WDR35, ZIC1
Laboratory 4	**(65)** ALPL, ASXL1, B3GAT3, CD96, CDC45, CDT1, COLEC11, CYP26B1, EFNA4, EFNB1, ERF, ESCO2, FBN1, FGF9, FGFR1, FGFR2, FGFR3, FREM1, GLI3, GPC3, IFT122, IFT140, IFT43, IGF1R, IL11RA, KAT6A, KAT6B, MASP1, MEGF8, MSX2, NFIA, ORC1, ORC4, ORC6, P4HB, PHEX, POR, PPP3CA, RAB23, RECQL4, RSPRY1, RUNX2, SCARF2, SEC24D, SIX2, SKI, SLC25A24, SMAD2, SMAD3, SMAD6, SOX6, SPECC1L, STAT3, TCF12, TCOF1, TGFB2, TGFB3, TGFBR1, TGFBR2, TMCO1, TWIST1, WDR19, WDR35, ZEB2, ZIC1

It is evident that even for the same genetic presentation/condition, gene panels can vary greatly between laboratories, leaving it up to the ordering provider and genetics specialists to decide which laboratory's test would best benefit the patient the most, without increasing the burden of unsolicited findings.

1.4.5 Formation of Guidelines for Eligibility

As mentioned earlier, guidelines for which healthcare providers can order genetic testing, and which patients can access genetic testing differs across Canada, as these decisions are made on a provincial level. For example, the governing funding body in Ontario is the Ministry of Health. To examine the clinical validity and utility of genetic testing for epilepsy, a working group of Ontario epileptologists and geneticists was assembled to establish clinical criteria to determine patient eligibility for the test (Jain et al., 2019). This group determined clinical workup to be completed prior to proceeding with genetic testing, and tests like imaging, biochemical laboratory assessments, and consults with the appropriate specialists (Jain et al., 2019). Moreover, Cancer Care Ontario convened expert working groups to develop a comprehensive and standardized gene list for adults with suspicion of hereditary cancer (Bell et al., 2023). Expert working groups consisted of genetic counsellors, medical geneticists, laboratory geneticists and oncologists. Eligibility criteria for who to test was changed to align with the new panel, to determine an

estimated detection rate of 12.2% P/LP variants (Bell et al., 2023). New eligibility criteria were designed based on available evidence, and >80% of the group had to approve a statement to be endorsed as criteria. Clinical appropriateness was reported to be prioritized over resource limitations (Bell et al., 2023). This demonstrates the careful creation of guidelines and eligibility criteria in a way that balances best patient outcomes, while working within a resource-constrained system. As such, it is clear that guidelines for testing are developed at a provincial level and are not consistent across Canada.

1.5 Genetic Data Privacy

To some medical personnel, genomic data is perceived to be similar to other health data, which may be documented in one's medical record. However, others believe there are considerations to genomic data which may distinguish it from other types of health data, and therefore, it should be handled with more care (Naveed et al., 2015). Genomic data can be considered complex because it represents information about the patient and biological family members (Naveed et al., 2015). Existing challenges of data privacy in genetic medicine include the risk for re-identification and pseudo-anonymized data (Naveed et al., 2015). Re-identification refers to the risk of unauthorized parties identifying the proband through genomic data, as each person's data is unique (Naveed et al., 2015). Examples of re-identification include genomic variants on a Y chromosome being correlated with individuals' last names, or the possibility of someone having access to raw genomic data and correctly predicting features such as eye or hair colour, and even vocal characteristics (Gymrek et al., 2013; Lippert et al., 2017). Pseudo-anonymization refers to a method of protecting health information through removal of identifying features such as name or birth date, it may also include masking certain parts of the genomic data to decrease the risk

of identification (Lin et al., 2004; Naveed et al., 2015). However, there are considerations unique to genomic data that pseudo-anonymization may not be adequate in concealing, as there is the possibility of genotype-phenotype inference, which means that either a phenotype can be determined with just genomic data, or a masked genomic sequence can be revealed based on available phenotype (Naveed et al., 2015). Research from 2004 suggests that only 75 statistically significant single nucleotide polymorphisms are required to identify an individual by their genomic data, across a global population (Lin et al., 2004). As the field of genetics continues to rapidly evolve, views on genomic data sharing and privacy evolve as well.

1.5.1 Governing Acts

In Canada, the Privacy Act relates to the government's collection, use, and disclosure of personal information and applies to federal government institutions, including the Department of Health (Office of the Privacy Commissioner of Canada, 2018). Furthermore, each province has its own version of a health privacy act. For example, Ontario has the Personal Health Information Protection Act (PHIPA), Manitoba and Newfoundland and Labrador both have the Personal Health Information Act (PHIA), and New Brunswick has the Personal Health Information Privacy and Access Act (Cavoukian & Grant, 2004; Personal Health Information Act, 2023; Personal Health Information Act Bill NO.89, 2010). The purpose of these acts is to govern the collection, use, disclosure, and maintenance of health information, ensuring confidentiality and privacy for patients. In the USA, the federal Health Insurance Portability and Accountability Act (HIPAA) addresses the use and disclosure of personal health information and balances the permissions for important uses of health information versus protection of this information (Health Insurance Portability and Accountability Act of 1996, 1996). Moreover, the Genomic Information Privacy Act

of 2019 in the USA prohibits commercial genetic testing companies from disclosing identifying data and includes regulation regarding data privacy practices (Genetic Information Privacy Act of 2019, 2019). Through regulations like PHIA and HIPAA, personal health information is protected by custodians. In HIPAA, this includes providers in hospitals, nursing facilities etc. but not necessarily third-party companies like direct-to-consumer genetic testing companies (Sklar, 2020). Moreover, regardless of the organization housing the data, HIPAA allows for sharing of de-identified personal health information and does not account for the re-identifiable nature of DNA (Sklar, 2020).

In Canada, there is a federal Genetic Information and Privacy Working Group (GI&P) (Howe, 2023). This group was established to identify challenges that may be posed as genomic science and technology increasingly enter the Canadian sector. The GI&P has suggested an amendment to the Privacy Act's definition of 'personal information record' to clarify that genetic samples and information are included, as they are not specifically mentioned at this point. As such, data sharing and privacy specifically for genetic information is not always well defined in health privacy acts, and there is work being done to determine the best way to protect patients' privacy and rights (Howe, 2023; Sklar, 2020).

While Canadians rely on acts like PHIA, and Americans rely on HIPAA, it is important to note that personal health information transferred to another country is subject to the laws of that country (Office of the Privacy Commissioner of Canada et al., 2017).

1.5.2 Consent for Tests Sent to Other Provinces or Countries

A consent process for any genetic test is encouraged to include information about the purpose of the genetic test, understanding of the sample collection (e.g. blood draw/saliva sample), data sharing of a sample with the laboratory performing the test, and any risks associated with performing the test for the patient or family member (Ministry of Health Provincial Health Services Authority, 2021). Various provincial genetic testing departments encourage providers to inform patients when their genetic test may be performed outside of the province or country, and as such, make it clear that their health data would be under foreign disclosure laws. With this information, along with knowing where their sample and health information will be sent, patients should be able to make informed decisions on whether genetic testing is right for them. Samples for SGT may also be sent outside of Canada, so disclosure regarding foreign health laws is encouraged; however, there are also consent points unique to SGT which will be covered in section 1.6.3.

1.6 Genetic Testing Pathways

At the initial integration of genetic testing into medical practice, genetics professionals such as geneticists and genetic counsellors were the primary providers discussing and offering genetic testing. In Canada, a frequently practised pathway of genetic testing includes a pre-test appointment to discuss the benefits and limitations of genetic testing, and a post-test appointment to disclose results (Unim et al., 2020). During the pre-test phase, patients meet with either a genetic counsellor or geneticist to review medical and family history which may determine a probability of a specific genetic disorder based on a patient's symptoms. After this assessment, genetic testing may be offered to a patient, and a decision is made about whether to pursue testing (Uhlman et al., 2009). The genetic healthcare provider would discuss the

benefits, limitations, and nuances of genetic testing, and provide education about the possible suspected diagnosis, such as inheritance patterns and impacts on personal or family health outcomes (Uhlman et al., 2009). This discussion and education is considered integral to a patient providing informed consent to proceed with the genetic test (Ormond, 2013). In the post-test session, providers receive genetic test results and discuss the report with their patients. This discussion includes the result, subsequent healthcare management options, implications for family members, and psychosocial counselling (Uhlman et al., 2009; Veach et al., 2018).

1.6.1 Genetics Workforce in Canada

Both genetic counsellors and clinical geneticists are a scarce resource in Canada, with the entire country consisting of approximately 111 geneticists and 484 genetic counsellors (Canadian Medical Association, 2019; Lambert et al., 2022). Moreover, 89% of genetic counsellors reside within the four provinces of British Columbia, Alberta, Ontario, and Quebec (Lambert et al., 2022). While most of these providers reside in urban areas, 18.5% of the Canadian population does not reside in urban areas that are easily accessible to genetics services. This leads to various provinces having differing amounts of clinicians per population and contributes to lengthy wait times for a genetics consultation (Lambert et al., 2022). Even in Ontario, the province with the most genetic counsellors, wait times can range from 1 month to 2 years. In provinces like Newfoundland and Labrador which has fewer genetic counsellors and geneticists, the wait time for genetic counselling services can be up to 3 years long, and even longer for geneticists (Lambert et al., 2022).

1.6.2 Mainstreaming of Genetic Testing

With only 1.28 genetic counsellors for every 100,000 people in Canada, the need for alternative models of genetic service delivery is increasing (Lambert et al., 2022). Within the genetics space, 'mainstreaming' refers to non-genetics healthcare providers ordering genetic testing for a patient. For example, in many provinces, neurologists are able to order neurology-related genetic testing for their patients, and oncologists in Ontario can order genetic testing for cancers when patients meet certain criteria (Gillies et al., 2023). In Quebec, cardiologists can order genetic testing for conditions such as familial hypercholesterolemia without involvement of a genetics specialist (Unim et al., 2020).

Whether or not certain specialists can order genetic testing, and which tests they are able to order differs based on guidelines created by each province. Mainstreaming is currently gaining traction in oncology across many provinces. As such, this requires non-genetics specialists to identify individuals at risk for genetic conditions and integrate genetic discussions into their practice (Dearing & Taverner, 2018). Mainstreaming is increasingly being used to offer higher volumes of genetic testing due to the constraints of a small genetics workforce. If oncologists order genetic testing for certain cancer conditions, this eliminates the need for all patients to be referred to medical genetics departments. Practices vary amongst clinics, but a common model of care may include a follow up a by genetic counsellor should the genetic test result identify a variant that is pathogenic (P) or likely pathogenic (LP) (McCuaig et al., 2021). Mainstreaming programs are generally set up and supported by local geneticists and genetic counsellors (Dragojlovic et al., 2023). These individuals would support education about genetics practice for

non-genetics providers and create comprehensive guidelines and criteria for genetic testing (Dragojlovic et al., 2023).

1.6.3 Sponsored Genetic Testing

While mainstreaming is gaining traction, provincial health care systems still limit which providers can order certain genetic testing, including referred out tests. SGT is a pathway for healthcare providers to access genetic tests for patients. Sponsored genetic tests are funded in partnership with biotechnology and biopharmaceutical companies for patients who meet eligibility criteria for certain conditions (Rush et al., 2022). Integral to SGT programs is a consent and agreement for the biopharmaceutical company to receive patient data—the kind of data shared varies by the agreement between the biotechnology company and testing laboratory. SGT programs are available for both monogenic conditions and somatic tumour testing, and it is marketed to both genetics and non-genetics practitioners by the sales representatives of the testing laboratories. However, there is limited information regarding the potential impacts which may result from the use of SGT in Canada (Dellefave-Castillo et al., 2022; Larson et al., 2023). Current research in SGT is mostly conducted in the USA, where the studies focus on aspects such as clinical findings e.g., diagnostic yield, research on genotype-phenotype correlations from SGT, and removing financial barriers in underserved populations (Bartels et al., 2024).For example, published data on genetic testing from the KIDNEYCODE project, which is an SGT program, noted a 27% (234/859 patients) molecular diagnostic rate (Lieberman et al., 2022). This SGT program used specific eligibility criteria to identify patients with cystic kidney disease, and found genetic variants providing diagnoses of Alport syndrome, polycystic kidney disease, and other kidney disorders in patients (Lieberman et al., 2022).

Early SGT programs first emerged for rare metabolic disease where sponsors (pharmaceutical companies) would cover the cost of enzyme studies to identify potential patients who may benefit from clinical trials or treatments in development (Bartels et al., 2024). With advancements in genetic technologies such as the availability of NGS, companies have since shifted to identifying patients who may benefit from clinical trials and/or gene therapies created by their organizations through genetic testing (Bartels et al., 2024).

There are multiple international genetic testing laboratories which offer SGT to Canadians, and these are funded by various partners in the pharmaceutical sector. In Canada, there are approximately 24 SGT programs available. The available SGT programs cover a range of conditions, including skeletal dysplasias, retinopathies, metabolic conditions, cardiomyopathies, and renal issues, among others (Table 3) (Bartels et al., 2024). In Canada, SGT is generally operated through external laboratories and funders. An example of a program offering SGT is for individuals with suspicion of Wild-Type Transthyretin Amyloid Cardiomyopathy (Rapezzi et al., 2021). This collaboration between sponsoring pharmaceutical companies and the commercial clinical laboratory aimed to identify individuals with P/LP variants in genes causing Wild-Type Transthyretin Amyloid Cardiomyopathy who may be eligible for Tafamidis – a treatment created by the sponsoring biopharmaceutical companies (Rapezzi et al., 2021). Moreover, there is one provincial laboratory in Canada which has an in-house SGT program. (Connaughton et al., 2023).

Table 3: Summary of sponsored genetic testing programmes available to patients in Canada (testing may be done in Canada or internationally)* ©K. Bartels et al., 2024. Used with permission from BMJ Publishing Group Ltd.

Indication for testing by symptomatology or disorder being tested for	Number of sponsored programmes	Number of genes included in the testing panel†
Neurologic		
Cerebral palsy	1	425
Adult neurodegenerative disorders	1	26–33
Neurotransmitter disorders	1	45
Childhood epilepsy	1	302
Metabolic		
Long-chain fatty acid oxidation disorders	1	25
Lysosomal storage diseases	1	1–230
Hypophosphataemia	1	17
Primary hyperoxaluria type 1	1	3–40
Familial chylomicronaemia syndrome and hyperlipoproteinaemia	2	6–7
Rare calcification disorders	1	2
Thymidine kinase 2 deficiency	1	55
Neuromuscular		
Muscular dystrophies	1	1–211
Movement disorders and hypotonia	1	81
Hereditary ATTR amyloidosis	2	1–100
Skeletal		
Skeletal dysplasias	1	358
Immunologic		
Activated PI3K delta syndrome	1	474–574
Congenital neutropaenia, WHIM syndrome	1	574
Hepatic		
Acute hepatic porphyria	1	10
Cholestasis	1	77
Ophthalmologic		
Inherited retinal diseases	2	325
Programmes discontinued since April 2022*		
Inherited cardiomyopathies and arrhythmias	1	168
Chronic kidney disease	1	401
Hereditary prostate cancer	1	12
Leukodystrophy or genetic leukoencephalopathy	1	697

*This list may not be complete and is meant to illustrate the breadth and variety of tests available. Sponsored programmes were found using Google search, reviewing information provided on the laboratory websites and direct contact with the laboratory to confirm eligibility of Canadian patients when needed. This summary was compiled on 7 April 2022. The list of programmes was reviewed on 9 September 2022 and programmes that had since been discontinued were removed and listed separately.
†If multiple gene panel tests were available in one or multiple programmes, the range of number of genes on the panels is presented.

One reason for the use of SGT includes access to genetic testing for patients who may not otherwise be able to obtain genetic testing through their province based on eligibility criteria. Sometimes, eligibility criteria tend to be broader through SGT programs compared to provincial criteria (Bartels et al., 2024). SGT programs generally accept requests for testing from providers regardless of their specialty. Thus, patients who are offered SGT may not have to wait to see a genetics professional, either. Many times, the SGT program will have genetic counselling as an option (Larson et al., 2023). As such, the use of SGT may help fill a gap by bypassing provincial eligibility criteria and clinic wait times (Bartels et al., 2024). Additionally, as these programs are created to help identify patients who may benefit from clinical trials or therapies, there is the potential benefit of patients knowing whether they may be eligible for treatment or clinical trials improving health outcomes (Bartels et al., 2024). Relationships with industry can also promote research and development in the understanding of human genetics and creation of therapies (Larson et al., 2023).

There is limited existing data on the benefits and limitations of SGT. Two existing pieces of literature which inform current understanding on the perspectives of SGT are a Canadian position statement by Bartels et al. published in 2024 and an American commentary by Larson et al. published in 2023. The position statement is written by Canadian genetic counsellors and geneticists, whereas the commentary was published by researchers in public health, bioethics, physicians, and others with varying roles in the space of genetics. These statements provided some perceived benefits and limitations of SGT as stated above, but also focused on important considerations for providers thinking to engage with this model of genetic testing.

1.6.4 Genetic Professionals' Views on Genetic Testing Facilitated by Non-genetics Physicians

Even though some genetic testing in Canada is ordered by non-genetics specialists, there is a reported gap in the understanding and knowledge of healthcare providers who are not specifically trained in genetics (Coleman et al., 2023; Reed et al., 2016). In a study assessing medical students, it was evident that while genetics education in medical school is increasing, there are still many advances needed for it to be integrated into the medical school curriculum, to ensure physicians are comfortable with genomic medicine (Plunkett-Rondeau et al., 2015).

A study found that while primary care providers view genetic testing as important, they report discomfort with their knowledge and skill surrounding genomic medicine, and barriers in understanding processes (Mikat-Stevens et al., 2015). This included barriers in core competencies such as collecting relevant medical and family histories, how to counsel patients about a genetic risk, and providing information on management options (Mikat-Stevens et al., 2015). A study from Klitzman et al. in 2013 surveying internists noted that 73.7% of individuals rated their knowledge of genetics as very/somewhat poor and 87.1% reported similar feelings concerning guidelines for genetic testing (Klitzman et al., 2013). 79% of respondents felt the need for more training on when to order tests, 82% desired more information on how to counsel patients, and 77.3% wanted more information regarding how to interpret results (Klitzman et al., 2013). In a survey of Canadian physicians including family physicians, cardiologists and oncologists, most found that they did not have sufficient knowledge about genetic testing. Over half of the respondents perceived lack of clinical guidelines, and limited knowledge as barriers (Bonter et al., 2011). 31% reported there being too much paperwork, and 37% reported lack of time or resources to educate patients (Bonter et al., 2011).

Genetics providers agreed with the above based on their experience and interactions with other physicians. They noted that gaps faced by non-genetics HCPs included challenges with collecting or updating relevant family histories, lack of confidence in assessing genetic results, a lack of resources for discussions around implications of test results for family members, lack of comfort discussing information regarding benefits and limitations of genetic testing, obtaining informed consent, and risk management based on results (Coleman et al., 2023).

Gaps in genomics knowledge can lead to misinterpretation of results, such as incorrectly assuming a VUS is diagnostic or incorrect medical information about an incidental finding (Coleman et al., 2023; Larson et al., 2023). Gaps in physician knowledge can also lead to patient distress, and negative implications for family members who are identified as at risk for a genetic condition, but may not receive the proper genetic testing or management as a result. Recognition of these gaps in knowledge have led to initiatives to promote continuing genetics education in the form of modules or certificate programs (Reed et al., 2016).

From the perspective of genetics professionals, many of the competencies listed above, which non-genetics providers are uncomfortable facilitating, are crucial to the practice of genetics (Coleman et al., 2023).

While there is a lot of information for physicians to keep in mind when facilitating genetic testing, genetics providers agree that the lack of genetics workforce leaves genetic counsellors and geneticists unable to provide services to everybody (Coleman et al., 2023). Not allowing other professionals to offer genetics services would be limiting access to those who need testing.

This data suggests that there are gaps in knowledge regarding genetics in other specialties. However, long wait lists, and inaccessible provincial genetic testing may still leave these providers desiring genetic assessments for their patients and looking to SGT as a result.

1.7 Study Rationale

The accessibility and offering of SGT are increasing across Canada but there is currently limited data representing the benefits, limitations or impacts of this testing model. Exploring the perspectives of Canadian genetic counsellors, medical geneticists, and laboratory healthcare providers (Canadian genetics healthcare providers/ CGHPs) can provide professional perspectives on the impacts of SGT in Canada. This study focuses on perspectives regarding SGT for inherited monogenic conditions only and excludes SGT related to somatic conditions or tumours. This study will provide insight into current practices on the use of SGT and what CGHPs are identifying as benefits, limitations, or impacts. This exploratory project can provide a starting point for further research on SGT in general and within Canada.

1.7.1 Research Questions and Objectives

This study aims to answer the following question: What are CGHPs' experiences and perspectives on SGT programs, and what are the perceived benefits, limitations, and impacts of SGT programs within the Canadian healthcare system? There are three objectives of this study:

1) To describe CGHP's experiences with SGT.

2) Identify CGHP's opinions on the benefits, limitations, and impacts surrounding SGT.

3) Describe CGHP's perspectives on any impact of SGT within the Canadian healthcare system.

CHAPTER 2: METHODOLGY AND METHODS

This chapter describes the methods used to address the question of this research study. It starts with a description of the theoretical foundations of the research, followed by the design of the study and details on how participants were recruited. Subsequently, this section describes how data was collected and analyzed, and ends with a section on how trustworthiness was integrated throughout the project.

2.1 Theoretical Foundations

This study's paradigm consists of a constructivist approach (Lincoln & Guba, 1989). A paradigm is a worldview or perspective which acknowledges the complexity of the real world and is not meant to be proved or disproved (Lincoln & Guba, 1989). Key underlying philosophical foundations which make up qualitative research are the ontology and epistemology of the process. Ontology refers to how one understands their own reality and epistemology refers to how someone gains their knowledge (Ravitch & Carl, 2021). The ontology of constructivism claims that the knowledge holder constructs their reality based on their own information and experiences, and that there is no single truth, rather, multiple realities (Charmaz, 2006; Given, 2008; Lincoln & Guba, 1989). The epistemology of constructivism maintains that knowledge is a human construction, suggesting that the findings of this study exist based on the interaction between the participants and relevant stakeholders such as SGT programs, patients, and health funding ministries (Guba & Lincoln, 1989). As such, this study was guided by the fact that participants may have different perspectives and realities surrounding the use of SGT, which can change overtime. These realities will be derived and understood based on their experiences and information gathered throughout their careers. Constructivism also acknowledges the positionality of the researcher and understands

that the researcher is a tool within the study as there is an inability to completely remove oneself from the research process (Johnson et al., 2020).

2.2 Study Design

This study followed a qualitative design using an interpretive description approach to analysis. Qualitative research is a mode of inquiry grounded in understanding participants' perspectives on a topic, in this case, experiences with, and perceptions on SGT (Stafford et al., 2017). Qualitative research collects and analyzes non-numerical data based on naturalistic inquiry, and builds upon itself (Lincoln & Guba, 1994; Stafford et al., 2017) Interpretive description emerged from nursing research but has since been employed in health research external to nursing (Renjith et al., 2021; Thorne et al., 1997). Interpretive description aims to provide an understanding behind the 'why' of a clinical phenomenon and provide context to the data (S. Thorne et al., 2004; S. E. Thorne, 2008). By highlighting both similarities and differences, interpretative description seeks to provide a thematic and interpreted narrative of people's subjective perceptions of a clinical phenomena that may guide clinical practice (S. Thorne et al., 1997). As perceptions of CGHPs on SGT have not yet been explored, interpretive description is an appropriate method to understand the contextual experiences informing the current landscape and perceptions surrounding SGT.

Given the lack of pre-existing information on this topic, this study is also considered exploratory (Ravitch & Carl, 2021). An exploratory study seeks to understand something about a topic which is not well studied, rather than to make a conclusion about said topic (Ravitch & Carl, 2021).

This study received ethics approval from the University of Manitoba Bannatyne Campus Research Ethics Board with the approval number HS25987 (H2023:143).

2.3 Eligibility and Recruitment

Eligible participants were certified genetic counsellors, medical geneticists, or laboratory geneticists who worked in Canada and spoke English (Table 1). Even though laboratory geneticists, and some genetic counsellors did not interact directly with patients and offer genetic testing, they were still included in this sample to provide valuable perspectives as CGHPs. Participants were recruited through convenience sampling, snowball sampling, an e-blast to the Canadian Association of Genetic Counsellors (CAGC) and invitational email to the Education, Ethics and Public Policy (E2P2) committee part of the Canadian College of Medical Geneticists (CCMG). The CAGC e-blast was estimated to reach approximately 350 genetic counsellors, and the E2P2 committee reached 13 potential participants. Convenience sampling was used to purposefully recruit individuals from across Canada. Recruitment began in July 2023, via invitational email sent with the assistance of committee members, to eligible laboratory geneticists and medical geneticists. The e-blasts circulated to potential participants highlighted eligibility criteria. Please see appendix A for the e-blast. This was followed by recruitment of genetic counsellors via snowball sampling in August 2023. E-blasts were sent to CAGC and the EE2P2 committee in October 2023. Recruitment ended in November 2023. The aim of the study was to interview at least 15 individuals across specialties and across the country.

Table 4: Inclusion and Exclusion Criteria for Potential Participants

Inclusion Criteria	**Exclusion Criteria**
Speaks English	Does not speak English

Works in Canada	Does not work in Canada
Certified medical geneticists, certified genetic counsellors (CCGC/CGC), or certified laboratory scientists	Not certified by the CCMG, ABGC or CAGC

2.4 Data Collection

In depth semi-structured interviews were conducted to understand participants' views on SGT. The flexibility of semi-structured interviews allowed for the opportunity to gain in-depth responses and follow a participants' train of thought to gain a more profound understanding of their opinions (S. E. Thorne, 2008). Transcripts were coded to determine underlying patterns between interviews and formulate insights.

2.4.1 Interview Guide Development

The semi-structured interview guide was created through a literature search and in collaboration with committee members, who include a genetic counsellor, laboratory geneticist, a qualitative research expert, and a genomics research expert (Kallio et al., 2016). Semi-structed interviews allowed the researcher flexibility during the interview, permitting a deeper investigation into participants' experiences and perspectives on the topic (Ravitch & Carl, 2021). As this research was exploratory, a deeper understanding into participants' experiences aligned with the goals of the study. The interview guide consisted of three major topics:

1. Pre-existing experiences with SGT
2. Perspectives on benefits and limitations of SGT
3. Impacts of SGT in the healthcare system

The interview guide was piloted with a genetic counsellor meeting the eligibility criteria and observed by committee member (GH) who has qualitative research and interview expertise (Kallio et al., 2016). Both GH and the interviewee provided guidance and feedback to improve interview and probing techniques. These improvements included starting off the interview by asking participants "what is your general stance on SGT" as a method to gauge experience with SGT. Other suggestions included prompting for specific examples, and having participants talk through examples of times they have used SGT step by step, as this would help provide rich, experiential data. In addition, GH and the interviewee also provided feedback on the flow of the interview, and on the student PI's interviewing style. The interview guide was reviewed and edited by the student PI, CCL, and GH to improve the structure and clarity (Kallio et al., 2016). Please see appendix B for the interview guide, including revisions.

2.4.2 Interview Procedure

Recruited participants were scheduled for a Zoom meeting and sent the research consent form in advance via email. Please see appendix C for a copy of the consent form. Prior to beginning the interview, the student PI reviewed the consent form with the participant, obtained verbal consent, and got permission to sign the form virtually, on their behalf.

All interviews were audio/video recorded and transcribed via Zoom through the automatic transcription option. All outputs from the interviews were saved in the University of Manitoba secure research drive. After completing four interviews, on August 10, 2023, GH, CCL and DH met to discuss the interview process from the first two interviews, which were transcribed by DH verbatim by listening to the audio file and making changes to the Zoom transcription document. This meeting involved discussions surrounding improvement of interview style e.g. how to

validate participants' statements, or how to ask probing questions to gather deeper data. For example, if a participant noted an opinion, to ask questions such as "tell me more about why this is 'inaccurate' 'confusing' or 'acceptable' to you" if the participant used such terms. GH noted that if participants ask "did I answer your question" to restate that the importance of this interview is to not correctly answer questions but to explore thoughts on a certain topic and continue with that train of thought. Some suggestions around terminology were also shared, for instance, when asking about hypothetical situations, prefacing with the statement: "so I understand this may be tough to predict, but I just want a sense of what you think if [hypothetical scenario] may happen in the future".

GH also suggested the incorporation of field notes after each interview. Field notes were taken to provide any contextual information to the data within the interview. Field notes aimed to gather general impressions, central ideas, or any adjustments pertaining to the interview (S. E. Thorne, 2008). The following questions were reported in the field notes, from the perspective of the student PI:

1. What I think I am hearing
2. What may need additional exploration
3. What were 2-3 key messages I took away from the interview
4. What were the participant's general feelings on SGT

2.4.3 Transcription

Fourteen interviews were transcribed by Transcript Heroes Transcription Services, and four were transcribed by either the student PI or a research volunteer, Nicole Alcasid (NA). The interviews

were transcribed verbatim but filler words (e.g. *uhm*) were removed. The University of Manitoba (UofM) and the student PI signed a confidentiality agreement with Transcript Heroes Transcription Services regarding data privacy and security. Transcript Heroes Transcription Services is a Canadian-based company.

Audio verification of Transcript Heroes transcripts was conducted by NA. This involved listening to audio interview files while reading the transcript to ensure that the data is directly representative of the participants' dialogue. NA would keep track of any discrepancies in an excel file stored on the secured UofM research study drive and inform the student PI, who would review and edit as necessary. Transcripts were reviewed for any identifying information such as individual names, clinic names, and locations, which were removed to maintain participant confidentiality.

Participants were assigned a unique study ID to reduce identifying information being used. All study material was stored in the UofM's secure research drive. Study data and information will be stored for 10 years as standard procedure. Identifying information such as participant name, workplace, and province of work, were stored in a master log in the UofM's secure research drive. No other documentation was associated with identifying information, only the study ID number. There are no physical copies of any study documentation.

2.5 Coding and Data Analysis

The methodology used to analyze study data was interpretive description. Interpretive description aims to provide an additive layer of analysis to the data to answer the question of "why" a clinical phenomenon exists (S. E. Thorne, 2008). This research approach grapples with both the theoretical side of qualitative inquiry but is also well versed within the realm of

qualitative research for clinical practice and utility through the development of new knowledge (S. E. Thorne, 2008).

As a methodology, interpretive description aligns with the paradigm of this study with a philosophical orientation that knowledge is constructed based on human experience and that there are multiple realities that can be studied holistically, as reality is contextual and subjective (S. Thorne et al., 2004). The foundation of interpretive description includes smaller scale qualitative investigations for a clinical phenomena of interest to capture patterns and themes within perceptions of the knowledge holders with the goal of understanding or providing utility based in a clinical phenomena (S. Thorne et al., 2004). In keeping with this study design, this methodology often works with data collection processes such as interviewing, and an inductive approach to analysis which requires reflective and critical examination in the interpretation of the informed questioning (S. Thorne et al., 2004).

Thematic analysis was the method used to analyze the data. Thematic analysis is a technique used to identify patterns in the dataset through similarities or differences (Braun & Clarke, 2008). This is a valuable method for exploratory qualitative studies as it provides a rich description of the data, to interpret and represent perspectives across participants. To conduct thematic analysis, the student PI first familiarized themselves with the data through memoing of the first three transcripts. This involved reading the transcripts in detail and writing any thoughts about the data which were either contextual or literal. Once the student PI became familiar with patterns across the first few transcripts, a codebook was developed (Ravitch & Carl, 2021). The codes were used to categorize and group data based on patterns, which were subsequently organized in overarching themes (Ravitch & Carl, 2021). The initial codebook was created using an inductive

approach. This means that the codes were derived from the data rather than a pre-existing literature. Deriving codes directly from the data helps stay true to the participants' thoughts, and provides rich insight and analysis for an exploratory study (Ravitch & Carl, 2021). Essentially, the codebook was a tool built from the outputs of participant interviews to form patterns between cases. Please see appendix D for the final codebook. Codes consisted of larger sections of text reflecting possible themes relevant to the study question rather than individual analysis of each word or line (S. Thorne et al., 2004). An iterative approach was used for analysis, so codes could be re-interpreted, removed, added, or checked for alternative explanation to the data throughout the analysis process, as subsequent interviews were conducted and analyzed (S. Thorne et al., 1997).

While the completion of data collection was thought to be determined by thematic saturation, it is prudent to note that there are precautions in dependency of thematic saturation to determine this end point (S. E. Thorne, 2008). As participants represent unlimited variability in perceptions, there is always the possibility that further data can be presented which differs from the outcomes of the study. Rather than claiming that all possible data has been collected and presented, researchers can evaluate whether the existing data is supportive of a rational narrative through what was ascertained from their data (S. E. Thorne, 2008). Thus, data was collected in this study, and themes were well-reinforced through patterns from multiple interviews to create a rational narrative on participants' perceptions.

2.6 Trustworthiness

Validity refers to the appropriateness of the data collection tools in addressing the research questions and findings, along with the truth and accuracy behind the research findings (Johnson et al., 2020; Ravitch & Carl, 2021). Rigour is the overall thoroughness of the research project (Johnson et al., 2020; Ravitch & Carl, 2021). Validity and rigour are both encompassed under trustworthiness as a broader concept achieved through four elements: credibility, transferability, dependability, and confirmability (Nowell et al., 2017; Shenton, 2004).

Credibility was assessed in many ways throughout the study design. Credibility aims to internally suggest how congruent the findings are with reality (Shenton, 2004). This included the purposeful choice of semi-structured interviewing as the data collection tool to allow for free expression of participants (Shenton, 2004). Additionally, the student PI met with committee members after the first few interviews to review the data together. The student PI and CCL blind coded four interviews to compare and contrast variations in coding and understanding of the data (Nowell et al., 2017). Transcripts to blind code were selected by the student PI to represent a wide range of themes and participant types. Differences in coding were discussed and rectified. Overall, these processes involve multiple members and checkpoints, promoting researcher triangulation to maintain credibility of the research process. The student PI and CCL also met weekly or bi-weekly through the course of the study to promote collaborative research practices and discussion. The study was also scrutinized through four committee meetings at various points of the project to bring up novel questions or perceptions to strengthen the research design and arguments made.

Transferability refers to the extent by which the findings of the study can be applied to other situations (Shenton, 2004). It is notable that qualitative research and thus, naturalistic inquiry, is not meant to be generalizable. However, field notes which allowed the student PI to reflect on the interview immediately after, and add any necessary contextual information may be used as a way to provide context to the data, which can assist in understanding the transferability of the findings (Shenton, 2004). The physical environment in which the participant resided as a 'contextual factor' was out of the control of the study PI. An iterative and comparative approach to analysis also prompted trust in the transferability of data (S. Thorne et al., 2004).

Dependability addresses an issue of reliability in qualitative works, or as known in positivist research, reproducibility (Shenton, 2004). Within this study, dependability was imparted through keeping detailed documentation. The study design and plan were well documented ahead of time, alterations in the interview guide were documented, and a volunteer audio verified all transcripts (Shenton, 2004).

Confirmability can be described as the qualitative researcher's sense of objectivity (Shenton, 2004). To reduce the affect of investigator bias, efforts were made to engage with all committee members and incorporate feedback from multiple individuals in all processes of the study (Nowell et al., 2017). This included the interview guide creation, data collection, and data analysis processes (Nowell et al., 2017; Shenton, 2004).

2.7 Reflexivity

Qualitative research relies on the researcher's interaction with participants, and the interpretation of the researcher. As such, understanding and reflecting on how one's own biases

and assumptions may affect a study is a key practice referred to as reflexivity. (Ravitch S, 2020; Ravitch & Carl, 2021). Throughout the research process, the student PI reflected upon personal beliefs, biases, and roles which may influence data collection or analysis of the research topic. After each interview, the student PI also noted how their perspective or understanding on the topic of study may have been influenced by a participant's responses in the field notes.

2.8 Positionality

Positionality refers to the researcher's acknowledgement of the position they have adopted in a research study and how that may influence the research process and outcomes (Ravitch & Carl, 2021). The student PI is a genetic counsellor in training and has been supervised by five study participants for clinical training requirements. They have an understanding of genetic testing processes within the clinics and provinces where they have trained, including insight from these clinics as to how or whether SGT was being used. The student PI has spoken with representatives from pharmaceutical companies involved in SGT programs at conferences out of curiosity. The student PI has also ordered SGT for patients in clinical rotations and returned results from SGT to patients which were ordered by non-genetics healthcare providers. This gave the student PI insight into clinical practice surrounding SGT both within the genetics and non-genetics specialties.

3. RESULTS

This chapter discusses the results of the study. It begins with an overview, including a description of the study sample, followed by an outline of the qualitative themes which are subsequently explained in greater detail.

3.1 Description of Study Sample

Eighteen CGHPs were interviewed. Interviews were conducted between August 1st and November 9th, 2023. Recruitment was undertaken in three independent waves. For the first wave, 57 individuals were invited to participate via convenience sampling, 12 individuals expressed interest in participation and ten were interviewed, the other two were lost to follow up. The second wave consisted of an e-blast to the CAGC, consisting of approximately 350 genetic counsellors, 10 responded and eight were interviewed. One genetic counsellor was not yet certified and thus, ineligible, and another was not interviewed due to multiple existing participants from the same province, as we aimed to stratify recruitment across Canada. For the third wave, thirteen CGHPs part of the E2P2 committee received an e-blast in an attempt to recruit additional geneticists, there were no interested respondents. The recruitment schematic can be found in Figure 1.0. Interviews lasted on average 46 minutes (range: 35 minutes – 67 minutes).

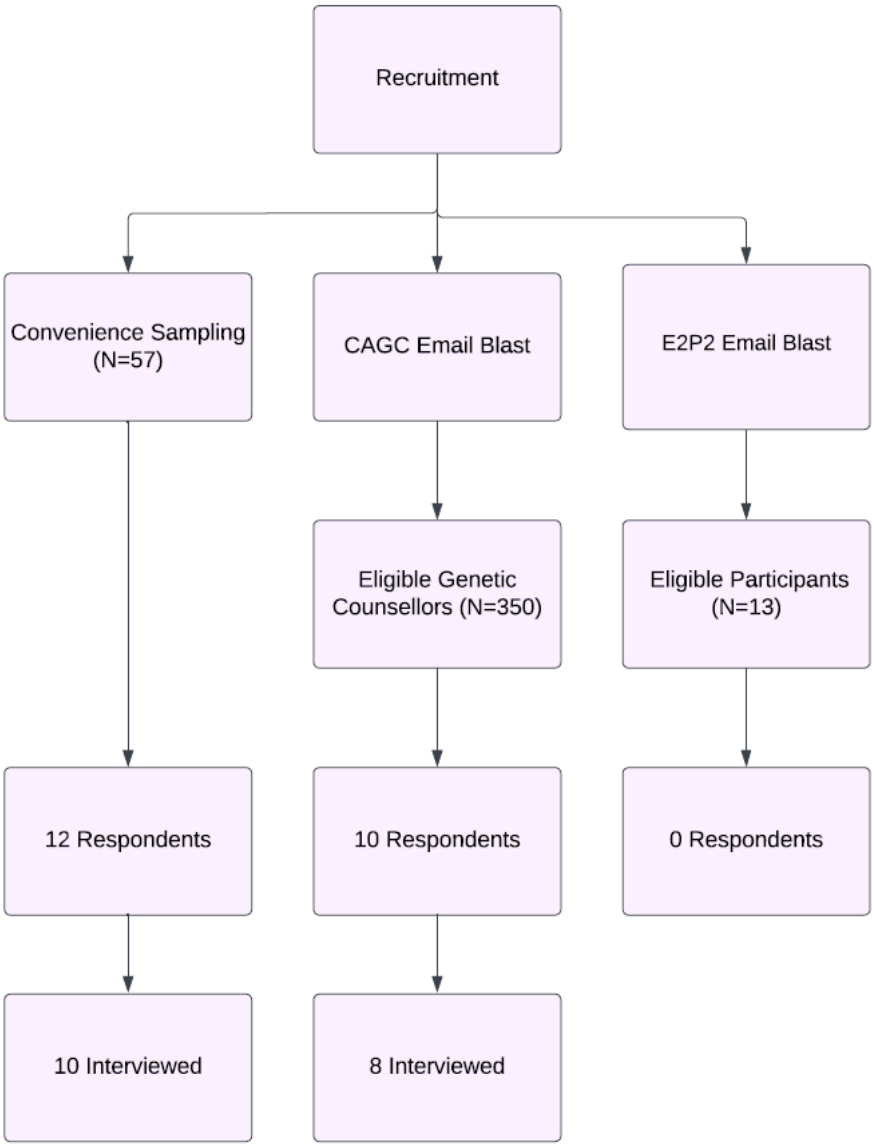

Figure 1: Recruitment Flow Chart

Twelve genetic counsellors, three medical geneticists, and three laboratory geneticists were interviewed. Participants reported 1–25+ years of experience (Table 5). All participants were from urban areas and practiced in varying specialties (Table 6). Participants were sampled across six provinces, including Alberta, British Columbia, Manitoba, Newfoundland and Labrador, Ontario, and Saskatchewan. Of the 18 participants, 12 reported currently working in a patient facing role

(Table 6). Of those 12, eight reported having ordered SGT before. Frequency of SGT use was not directly measured amongst those participants; however, all eight participants reported intermittent use as there are limited indications for which SGT programs are available. All medical geneticists reported use of SGT, five genetic counsellors reported use of SGT, and one laboratory geneticist reported direct interaction with SGT through an in-house program. No one reported official institutional policies surrounding SGT. Apart from the three laboratory geneticists, participants not in patient facing roles consisted of those working in industry, laboratories, or pursuing other professional interests (Table 6). All had previous clinical experience.

Table 5: Participant Demographics

Characteristic	**Responses**	**Number of Participants (N=18)**
Profession	Genetic Counsellor	12
	Medical Geneticist	3
	Laboratory Geneticist	3
Years of Experience*	0–5	5
	5–10	4
	10–15	3
	15–20	2
	20+[†]	4
Province of Practice	Alberta	4
	British Columbia	2
	Manitoba	4
	Newfoundland and Labrador	1
	Ontario	5
	Saskatchewan	2
		(N=19)[‡]
Current Workplace	Public Healthcare system[§]	16
	For profit organization[‖]	3

*Durations do not include residency training for medical or laboratory geneticists
†Medical geneticists with 20+ years in practice include those who practiced as paediatricians first
‡One participant currently works for both a for-profit organization and the public healthcare system
§Some participants have previously worked at for-profit organizations
‖All participants have previously worked for the public healthcare system

Table 6: Participant Specialty and Reported Use of SGT

Reported ordering of SGT	**Profession (N=18)**	**Specialty (aggregate)†**
Yes	Medical geneticist (N=3) Clinial genetic counsellor (n=5)	Cancer, pediatrics, prenatal, cognitive disorders, general, ocular
No	Clinical genetic counsellor (n=4)	General, cancer, cardiac, prenatal
N/A	Laboratory geneticist* (N=3) Laboratory genetic counsellor* (N=1) Industry genetic counsellor* (N=2)	

* These professional roles do not involve ordering genetic testing for patients and as such, ordering of SGT is not applicable

†Most participants reported practicing in more than one specialty

3.2 Overview of Qualitative Findings

Results from this study suggested that CGHPs were divided on their perspectives of SGT. Some providers noted they had ["mixed thoughts" (P02, laboratory geneticist)] about SGT but noted that there was a space for SGT based on circumstance. Others either agreed with the concept of SGT or disagreed with its use in practice. Three themes were identified to describe differences in perspectives: 1) adequate transparency surrounding data sharing 2) the desire for a workaround to improve access, and 3) consideration of budgets within a publicly funded healthcare system. Within these themes, there are divergent perspectives as illustrated in Figure 2.0. Proponents of SGT were not concerned about transparency regarding what data would be shared between the genetic testing laboratory and sponsoring third-party company. These individuals also reported that circumstances sometimes required a work around to circumvent provincial processes, and that there is a need for SGT to advocate for increased provincial funding for genetics services. Conversely, individuals opposed to the use of SGT noted that SGT programs have a lack of transparency regarding how patient data is shared and used, that ideally a public system should be able to care for all patients who require genetic testing without the need for work arounds,

and that there is a responsibility to consider how privately funded testing could be detrimental to future genetic testing budgets. Furthermore, learning about participants' perspectives regarding non-genetics physicians' use of SGT was not part of the objectives of this research study. However, this topic was heavily discussed by all participants. All participants had considerations for their non-genetics colleagues regarding the use of SGT. As such, 4) non-genetics HCPs' use of SGT, was the final theme which emerged from this data.

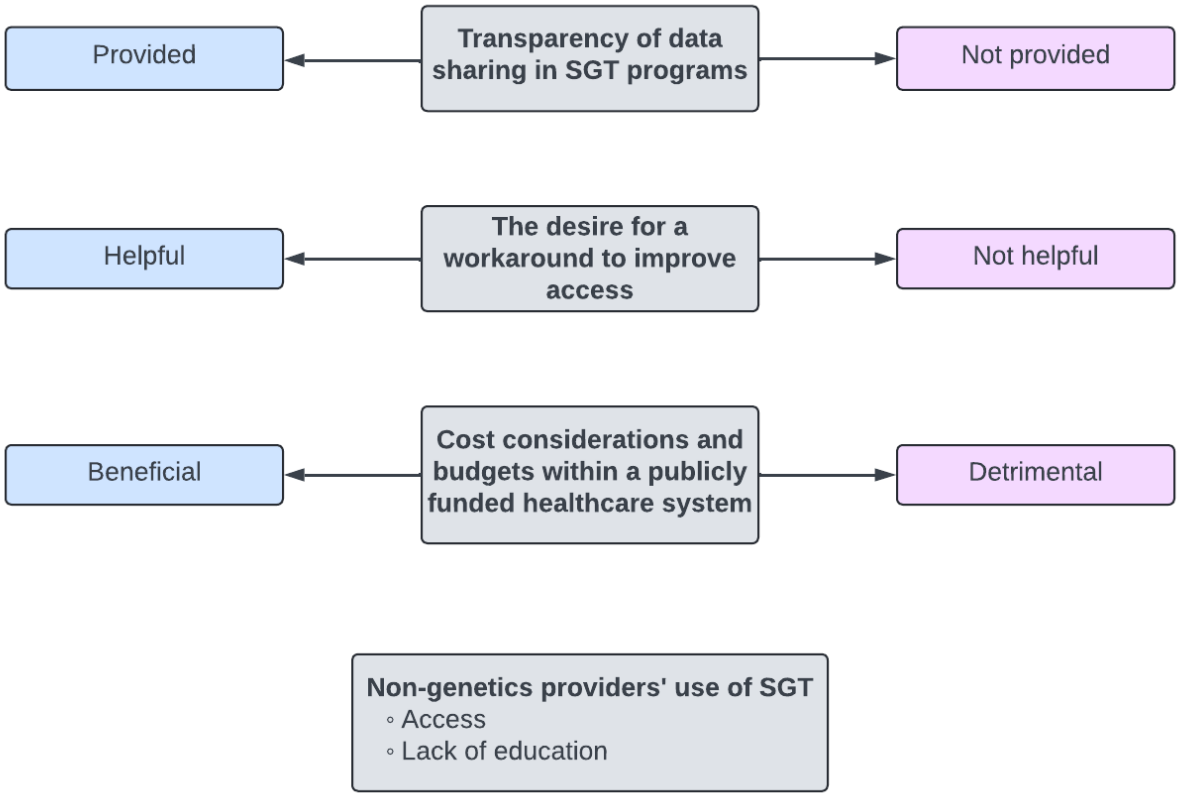

Figure 2: Summary of main themes influencing Canadian genetic healthcare providers' perspectives on sponsored genetic testing (SGT) and the spectrum of opinions in emerging themes between proponents of SGT and skeptics of SGT

3.3 Theme 1: Transparency of Data Sharing in SGT Programs

The topic of consent for genetic testing, along with transparency about patient data privacy and sharing within SGT programs was prominent throughout interviews. Participants had varying perspectives and comfort levels surrounding the amount of information provided on consent forms, or directly by the program regarding use of patient data, and how to communicate this to patients.

3.3.1 Participant Perception of the Consent Process for SGT Programs

Participants either felt that consent forms from SGT programs offered adequate information to ensure that patients could provide informed consent, while others felt that information was vague and lacked details, making them less comfortable about the process of obtaining consent from patients to participate in SGT. In this context, transparency refers to the clarity with which SGT programs identify how patient data is moved and used. For example, being transparent may include communication on whether the data is de-identified, what exactly is shared with third-party sponsors, how long data is retained, and whether data will be shared with potential future sponsors.

Some participants presented an opposing argument and felt that consent forms for SGT programs were sufficient. In fact, they expressed strong opinions regarding the process of obtaining consent in genetics practice and felt that genetic testing consent is supercilious to begin with. As such, they believed that genetics professionals put a lot of emphasis on consenting patients for genetic tests, whereas this is not the standard of practice amongst other specialties. For example, other

specialties may not warn patients about every possible incidental finding from a diagnostic test, but it is part of a consent process for genetic testing.

> *"I would say, for any woman that's had an ultrasound, because of a pregnancy, were they ever told this ultrasound could identify ovarian cancer? It could identify uterine cancer, it could identify cervical cancer. We may find x, y, z. I think, we are micromanaging perfectionists in genetics, and we've got to let go. Nobody is consenting to things the way genetics does." (P17, genetic counsellor)*

Participants with similar views agreed that small details such as information regarding sample storage and data use in a consent process are generally not discussed in other aspects of healthcare, yet it is an expectation in the consent process for a genetic test.

> *"So, I think we actually practice genetic exceptionalism with our consent process...The fascinating thing is if you've ever gone in for surgery, it's very likely that you've got a pathology specimen stored at the hospital. I don't think you would ever have been asked, "Would you like it stored or would you like it destroyed," right. Whenever you have your blood test taken do they mention that there may be data-sharing involved? They never do yet why do we do this for diagnostic tests where for example you've come in and we suspect you might have Fragile X and we do the test and it's positive. I don't see the difference." (P05, medical geneticist)*

As such, some participants believed that the consent for genetic testing included much more information giving than what is necessary for patients to make an informed decision. Similar

outlooks were given to the consent process for SGT, where basic information was required for consent, but that explaining every specific detail was not necessary, unless requested.

> *"To be honest, I don't consent the patients very differently for sponsored testing…I do mention, there are some sponsored tests where we know the sponsor has a particular medication or treatment for the conditions tested, so if it's relevant, I do mention that anonymized data may be shared with the sponsor and that I may be contacted, if it's positive, by the company to say, hey we notice you have a patient with this condition, we have a treatment. And that should be the only data that's shared. So, I don't see that as problematic because if I have a diagnosis anyway that has treatment, I would be the one reaching out to the company, so whether they reach out to me first or I reach out to them. And I'm upfront about this with patients, when it's relevant." (P13, medical geneticist)*

Participants who did not perceive that they had enough information to receive informed consent from patients viewed SGT consent forms as vague when it came to data sharing agreements and policies between genetic testing laboratories and third-party companies. One participant shared their thoughts about data sharing from a patient perspective.

> *"I guess from the perspective of a patient, I have concerns about what's done with their data. I know that a lot of times the labs will say that only the one variant or only the one gene that's important they're sending to the company. But whether that's actually what's happening is not available, anywhere for review. And the form that the patient's signed, very often does not include that language. So as much as the company is assuring us that*

> *that's all they're doing, they actually have no legal obligation to do that, and can sell more of the patient's data at a later date. I'm sure that is covered. (P12, genetic counsellor)*

This participant mentioned that patient data may be sold to third parties in the future who are not yet affiliated with the company at the time of the initial consent. As such, they were weary about future data sharing possibilities given that verbiage surrounding this possibility was not present on all consent forms.

Participants also acknowledged that SGT programs are not homogenous. They noted that some programs are more trustworthy than others and better relay information regarding data sharing.

> *"I think it's variable. I haven't looked at any [consent forms] recently, but I have in the past five years, and I would say some are more explicit about exactly what data is being shared. And others are very vague, which raises a lot of question marks around it." – (P14, genetic counsellor)*

Essentially, some participants questioned data sharing procedures when consent forms were vague in terms of describing what type of data is shared, with which third party companies data is shared, or whether it will be shared with future collaborators not yet disclosed.

Participants who viewed consent forms as vague described a desire for more transparency on those forms to adequately understand the specifics of how data is shared with the sponsors.

> *"I think that is one of a lot of people's biggest concern is what's actually happening with the data. Is it anonymized going to the pharmaceutical company? Which I think most people think it is, but yeah, no one really knows…And I think that's probably why genetics*

is more suspicious. Because my experience in working with non-genetic specialists…data sharing is not even, even if you bring it up with them, it's not something that triggers that kind of a reaction like it does in genetics. So it may be just literally the history of genetics that's kind of lead us where we are." (P11, genetic counsellor)

This participant noted that data sharing is a topic which "triggers" genetics practitioners, but that other practitioners do not have the same reactions to sharing genetic data.

3.3.2 Participant Perception of Data Sharing and Privacy in SGT Programs

As introduced in the above results about discussing consent forms associated with SGT programs, participants also viewed the information surrounding data sharing and privacy they received from SGT programs with two opposing arguments. Some participants viewed the information they received either from representatives, websites, or consent forms as adequate and others wished for further transparency to better understand how genetic information and data are shared with sponsoring companies. For example, whether data is identifiable, or whether just variant information was shared. One participant mentioned that they were not even certain whether the genetic testing laboratories were aware of how patient data was used.

"I wish I had a little bit more understanding. I've only ordered them a few times, and every time I do I try and get a little bit more understanding of what actually happens with the data. As transparent, I guess, as [the genetic testing laboratories] can be, because maybe [the genetic testing laboratories] don't know what they're selling their data for. So, I wish I personally had more understanding of that before ordering it. But it's hard and you get limited information." (P08, genetic counsellor)

The uncertainty about third-party companies having access to patient data and future, unvetted, sponsors paying to access data left some participants questioning what types of third parties may eventually have access to patient data.

> *"What was important for us to clarify…is, in these programs, where sponsorship is open – so for '[genetic testing company], it was we are going to be inviting anyone who wants to sponsor this program to sponsor this program. And [what] we weren't clear about was, OK, if someone comes on as a sponsor – so say someone today has testing through this program, and that data is part of the sponsored program. Does that mean that any company that signs up later gets access to that patient's data?" (P06, genetic counsellor)*

Due to this uncertainty, there was a desire for increased transparency for both provider and patient knowledge surrounding specifics of data sharing, with the potential of conversation between the SGT programs and genetics clinics. Some providers desired concrete information to share with patients regarding how their data may be used.

> *"But yeah, it's just sometimes I just feel like I wish I just knew a little bit more and didn't have to kind of I guess generalise it to people that they're going to use your data in any which way they want. Is that OK with you? So, I guess maybe better communications with the sponsored labs. Like I feel maybe they don't reach out to us as much because we're already ordering genetic testing… and spending money at their labs and maybe they don't come to us about the sponsored testing as much. So, yeah, maybe if they did explain things a little bit better, that would be more positive." (P08, genetic counsellor)*

Other participants agreed that information on the consent form regarding data sharing information was sufficient, and recognized that SGT was being ordered through the same genetic testing laboratories to which their province sends funded genetic tests. As such, they reported holding the same reservations regarding data sharing and privacy for any outsourced genetic test conducted by a for profit laboratory, regardless of whether it is sponsored since laws and policies on genetic data sharing in a particular country would not differ for a provincially funded or sponsored genetic test.

> *"The way I see it and I communicate this to patients, that it's a necessary evil to offer sponsored testing. But it's also a necessary evil to use, you know, for-profit clinical labs, for send out testing anyway, even if it's covered by [provincial healthcare funder], and these are often the same companies that offer sponsored testing that we also use for clinical testing when it's funded. So, my pre-test counselling is very similar. I talk about how we can't guarantee confidentiality and privacy. And that when we send out a DNA sample to a for-profit medical lab, we do not have control over what happens to their sample and that there are clinical apps, especially in the United States, that use DNA data as a revenue stream. I'm upfront about that, and that's true whether it's sponsored testing or whether it's just a send out that's covered by [provincial healthcare funder]." (P13, Medical Geneticist)*

Furthermore, one participant noted that there was a misconception amongst CGHPs about data sharing and privacy surrounding SGT programs, since SGT data is held to the same standards as any other patient data.

> *"I'm not sure where this misconception about what is and isn't shared comes from. All medical information in Canada is protected under certain patient privacy laws. That remains the same for a sponsored testing program, for any medical grade test. They have to have the same privacy law, the same level of stringent privacy for patient information as an x-ray clinic. I don't understand where it came from, that misconception." (P17, genetic counsellor)*

Most participants believed that patient data was de-identified in the SGT programs they engaged with. However, one participant mentioned an associated clinical trial frequently contacting their patients directly.

> *"So sponsored testing that we order through [genetic testing laboratory], most of the time, the companies are receiving de-identified data, and they're contacting the physician who contacts the patient. But for this trial, it is – the trial itself is copied on their results, and they get everything and they will contact the patient directly. So, I think both happen. I think the former is more common, but, in my experience, the latter happens all the time." (P12, genetic counsellor)*

A genetic counsellor previously employed by a genetic testing laboratory affiliated with a sponsoring company noted concerns about the affiliated company's motivations for offering SGT.

> *"So, I know what pharmaceutical companies will ask for, and that makes me uncomfortable. I also know that if we found, let's say, we did this, and we found a variant in the gene of interest, if it was path[ogenic], likely path[ogenic], great, they went down that pipeline. But if we found a VUS, the amount of pressure that that pharmaceutical*

company put on our lab to try to get it to increase to a likely path[ogenic], especially once the drug had gone to market, because that would mean that they would pay for the drug. So, there was honestly peer pressure to be like, 'So what can we do? How can we get you to make this [happen]? What more information do you need? Who do you need testing from? How can we get this VUS to a likely path[ogenic]?' And ignoring the fact that most VUSs don't go up to likely path[ogenic] or we need functional data to do it, and we need labs for that." – (P09, genetic counsellor)

This participants' previous experience with sponsoring companies suggested pressure to achieve P/LP results and noted that VUS were shared with the sponsoring companies, not just P/LP variants, which differs from beliefs of some participants quoted above.

3.3.3 Transparency Between the Provider and Patient

While the main focus of conversations with participants was surrounding their personal perspectives on data sharing, privacy, and consent for SGT; some individuals discussed the importance of maintaining patient autonomy in circumstances where SGT is an option. Out of the eight participants who reported having ordered SGT, three ordered it whenever available. These participants mentioned offering SGT alongside provincially funded testing as individual options, and two noted providing balanced information for both. These participants argued that it was the patient's right to make the decision best for them, meaning choosing the avenue of testing they preferred.

"…as long as you are giving the information, all the information to the patient to make their own choice, and they are giving informed consent, I don't have a problem with

> *it...some people told me that they felt like they were giving back a little bit as well, because when I explained that the data would be potentially used by pharmaceutical companies or other third parties to develop their own tasks, maybe work on drugs, who knows what they're doing with it. And they were like, 'Well, that's what I want. I want my data to be used to help my kids down the line or help other people in my situation, to be a part of kind of developing healthcare.' And so some patients really actually liked that aspect of [SGT] and were not so concerned about their data being shared." (P15, genetic counsellor)*

When participants offered SGT to patients, most still maintained the importance of informed consent. Some participants believed that their role was to provide patients with all possibilities for genetic testing available for their indication in a thorough manner, spending up to 20 minutes discussing the options.

> *"I feel as though the pretest counseling process that we do at our clinic, I go through each of those options of the [provincially] funded, the private pay, the sponsored, and really outlined for each patient what is it about each of these modalities that some people have issue with. I bring up the controversy around sponsored testing. I talk very frank about it with patients that there have been concerns raised, that this may in some ways be coercive. Are people truly understanding what they're signing up for? We have very frank conversations. I probably spent a good 20 minutes of each session around the access piece and going through each of these options for patients." (P18, genetic counsellor)*

Similarly, this participant noted that in scenarios where patients are given options, some may opt to pursue SGT noting *"we want to help with research, so that that's what we want to go with." (P18, genetic counsellor)*

However, participants noted that not all patients may be comfortable with the concept of SGT. One participant described a scenario in their clinic about a patient who received SGT via a non-genetics healthcare professional, along with the outcome.

> *"[Oncologists] were just basically telling the patient, 'We're just going to do some genetic testing, to see if we can find an alteration.' And it all came to light when a patient found out that this was a sponsored test, and all her personal, her clinical information had been sent without her consent. And then she made a complaint and then it all came to light, with what the oncologists were doing. So, they were they were told they had to stop, either stop or start doing the counselling kind of properly." (P15, genetic counsellor)*

These scenarios suggest that patients have a desire to play a role in decision making surrounding SGT as well.

All in all, data sharing and privacy was a prominent point of discussion for all participants who had different perspectives on the clarity of information provided. Some noted that consent forms were adequate, and others noted they were vague regarding use of patient data. Some participants felt that they had enough information from SGT programs to understand the important aspects of patient data sharing, and disliked the onerous process of obtaining consent for genetic testing, whereas others did not agree. Lastly, participants who had previously offered SGT to patients brought up patient values as an important consideration when using SGT.

3.4 Theme 2: Workarounds to Improve Access

Out of the eight individuals who had previously ordered SGT, four ordered it to gain access in scenarios where they thought genetic testing was indicated, but there were provincial restrictions limiting access to those tests. Some participants discussed workarounds to the out of province genetic testing application in hopes of circumventing the process, which can have strict eligibility criteria for patients or be more time consuming. The participants viewed SGT as an easier testing alternative. Participants who considered their provincial guidelines to be restrictive tended to find necessity and benefit in the use of SGT. Participants who did not feel as restricted by provincial guidelines tended to note less utility from SGT.

3.4.1 SGT Filling Gaps in Access to Genomics Care

In provinces where access to genetic testing was not viewed as burdensome or restrictive, participants were not as eager to perceive SGT as an alternate pathway for genetic testing. These participants understood that the use of SGT outside of a universal healthcare setting provides benefit and access, but believed that within Canada, health systems should be able to provide the proper genetics care for their patients.

> *"I think…outside of a universal health care setting, I can understand the need for [SGT programs] existence, especially in the US where not everyone has access to genetic testing. Under a single payer model, I feel that if it's medically indicated, it should be covered by the provincial health care system. And so, I do not feel that there would be a need to take a free test by a private company in order to save the province money, but at the cost of patient and provider data and privacy." (P09, genetic counsellor)*

In provinces where participants reported stricter eligibility criteria for patients to access genetic testing, they perceived SGT as an avenue for access, which may not otherwise be available. Participants also viewed the faster turn around times as a potential reason to opt for SGT compared to a provincially funded test.

> *"I ordered it relatively frequently…If they would meet our testing guidelines through the province, we would test that route. But otherwise, we would go the other route if they didn't qualify. Or if we were like, we need quick results because the sponsored panel through [genetic testing company], you get results…in less than two weeks." (P10, genetic counsellor)*

Participants also viewed some benefit in being able to order panels larger than the ones generally offered or funded by their provincial laboratories*, noting that "[Genetic testing company] had a [SGT panel] that we would order occasionally too, because that one actually had a whole bunch of genes, compared to some of the other [funded] ones that we [previously ordered]." (P10, genetic counsellor)*

Participants in provinces with strict eligibility criteria noted that sometimes SGT was the safer option, as patients clearly met criteria for the program, but that there was a chance if submitted to their out of province funding committee for the same genetic test, it may be declined. One participant remarked *"We want to make sure that we are able to order testing, but if we can't from a provincial [standpoint], we're going to use whatever other means that are available to us" (P10, genetic counsellor).*

Participants also commented on SGT filling a gap while waiting for their province to catch up with the needs of genetics laboratories and clinics. *"I think the ability of sponsored testing to fill that gap while the healthcare system identifies the needs, assesses the volume and then develops the testing [in local provincial laboratory] is what I've observed, and I see as a benefit." (P11, genetic counsellor)*

The notion of needing a workaround to avoid falling behind standards of care and practice was voiced by individuals in provinces who perceived guidelines and budgets as restrictive. One participant from such a province discussed how their funding for genetic tests was generally lacking *"…Our funding is always behind the need, because technology progresses so rapidly, and we find that the standard of care across Canada changes, and especially some other provinces have more funding and access to clinical genetic tests as needed" (P13, medical geneticist)*

Ultimately, participants voiced the importance of doing what was best for the patient, even if they did not completely approve of the concept of SGT, since it could be used to fill a gap.

> *"There are gaps here, there are gaps in patient care, there are gaps in access, and look at what we're having to do to ensure that our patients are getting relevant clinical genetic tests. We are having to make use of sponsored programs, because that is giving our patients access to these tests. We wish we didn't have to rely on them, and this is what we would love to see from you [provincial funding agencies] going forward. We don't need to be just silencing ourselves to be advocating for the provincial covering. In the meantime, though, it is giving certain patient populations access to tests that they wouldn't otherwise be able to get." (P18, genetic counsellor)*

However, some participants who used SGT to fill gaps deemed that going through the public health route would be preferred, but that was not always possible. *"I think if our lab had unlimited funding, you know, sure everything should go through the lab. But in the big picture…I think it's difficult for the lab to keep up with the demand for testing. So, if some things can be done to reduce the demand, sure." (P03, medical geneticist)*

Participants also noted that partnerships with companies external to the public health system can promote research and accelerate access to genetic testing and potential therapies. These are resources which may not have been otherwise available, if not for external collaborations. One participant commented on the dichotomy surrounding the benefit of accessing private partnerships versus practicing purely within the public scope. *"Yes, I'm very much in favour of having public genetic testing labs and kind of no external influence. But sometimes, you know, you can form nice partnerships with companies to try to accelerate access to genetic testing or therapeutics." (P04, laboratory geneticist*)

It is important to note that even participants who did not agree with the use of SGT, and believed they were from less restrictive provinces, understood the challenges of provincial restrictions faced by their colleagues. *"Yeah, I think it's interesting that a lot of places are using it because they can't get funding for the testing. And it's unfortunate that you have to use a sponsored test in order to get something that is justifiable." (P16, genetic counsellor)*

Similarly, others expressed understanding that there are differences between provinces, making the needs of their colleagues differ from their own, and begrudged health systems which set up this need for external testing.

> *"I feel like providers who work in provinces where they're more likely to say no [for approval of genetic testing], say that [SGT is] the same as genetic testing to make themselves feel better that this is the only avenue they have. Because if it were the same, why would they order any genetic tests that's covered? I think it's just a way to feel better about the crappy funding situation that they have in their province…I get it, why they would resort to that to help their patients. So, I begrudge the systems and the government more than I begrudge the providers, that they have put those providers in that situation to make that choice." (P09, genetic counsellor)*

Participants who perceived restrictive genetic testing guidelines or limited provincial laboratory funding seem to rely on the use of SGT for their patients who qualify, even though this test may not be their first avenue of choice. Most participants noted that ideally, the provincial healthcare systems should be able to cover the cost of genetic testing when indicated for their patients, stating that *"I think in a perfect world, I would rather see that need be filled by a functioning public healthcare system." (P12, genetic counsellor).* Similarly, another participant remarked on the necessity of SGT *"Well, I think it [SGT] is a necessary evil. That's the way I look at it. But, it does help fill gaps in clinical testing." (P13, medical geneticist)*

Overall, SGT is being viewed as a workaround by some participants whose provinces have strict guidelines and eligibility criteria for provincial funding for out of province genetic testing. These participants view SGT as an alternate way to achieve access to genetic testing for their patients.

3.4.2 The Burden of Provincial Processes

Of the eight individuals who reported ordering SGT, one individual always ordered it when they saw patients for indications where SGT was available, since the paperwork for provincial approval was more burdensome. In addition to this participant, other participants also identified provincial processes to be burdensome. In these cases, SGT provided a workaround to time consuming procedures. Using SGT meant that time consuming or complex provincial processes could be circumvented and the same genetic test could be ordered through an alternate route.

> *"With the provincial testing there's just so much more paperwork involved; the process is laborious. There are just numerous barriers in place and sometimes I cannot see the rationale for them. I'm all for understanding processes which make sense, but I'm not for processes that duplicate entry information and, you know, I don't know what they do with this information. Here we have a [provincial funding agency], and they require more forms. One of the staggering questions that is asked is, you know, "What is the rationale for this test" and so there is tick boxes. So, let's say you tick the box for reproductive risk counselling, there's another box then saying, "Please explain" and to me, that's actually completely redundant. But if you don't fill it out you get a call to ask, you know, why is that blank. So, I just think that the [provincial funding agency], if I can use the word, shows exceptionalism and protectionism in terms of how they run these tests and so I have objections to that." (P05, medical geneticist)*

Others who also described the approval process as laborious considered provincially funded genetic testing to increase turnaround time to results, because there was a wait time to receive approval before testing can even be sent out of the province or country.

> *"So there's a lot of paperwork and time around applying in some provinces and territories, applying to the government to fund out of country genetic testing, or out of province genetic testing. And it's a really burdensome process and it's slow, it can be very slow, some provinces are faster than others." (P14, genetic counsellor)*

Additionally, some provinces have regulations that providers felt mitigated their clinical discretion and policed their ability to order testing. For example, provinces dictating whether an exome could be ordered for a patient after they had a large panel which yielded negative results. In such situations, individuals have used SGT to provide work arounds and order tests as they see fit.

> *"In our province if we were to access a large panel [funded] through the province, they will not fund an exome. [But] If I order a panel which is sponsored and it comes back uninformative and the patient fits the [provincial] criteria for exome sequencing, which is generally standard throughout Canada, I can then access exome sequencing through the province. But if I had [first] ordered the [indication X] panel through the province, they would've declined it. They will say you've got to wait a few years before you come back for exome…So they will say, "This is a very good comprehensive panel [for indication X], what exactly are you going to find in an exome," and that's totally true what they're arguing. But it's a rule and it takes away from my professional discretion, that's what I object to." (P05, medical geneticist)*

Thus, time consuming application processes and long timelines to get approval for provincially funded testing may lead individuals to opt for SGT, which can have less complex paperwork and shorter wait times to results.

3.4.3 Workarounds for Non-genetics Healthcare Providers

In provinces where certain genetic testing is restricted to geneticists, participants identified that non-genetic healthcare providers used SGT as a workaround to order genetic testing themselves. Participants mentioned that some genetic conditions are common enough that genetics departments would not be able to maintain the demand for seeing those patients.

> *"I think...some of the things like the cholestasis panel or the epilepsy panel are just so easy to order and so frequent that it would be difficult on our system [medical genetics] to handle that increased volume. So that's why they're commonly done, and it's worked well for [non-genetics healthcare providers] using it. So, I guess in some ways it does fill a gap. But, you know, whether it would be the highest priority for testing that, I'm not sure." (P03, medical geneticist)*

Participants also noted timely access to testing as a benefit of non-genetics providers ordering SGT since wait lists for genetics consultations are very lengthy across Canada. Participants thought that SGT ordered by non-genetic providers increased genomics access for more patients.

> *"I find that it increases access to genetic testing to patients, for patients who don't have the resources to travel to a genetics clinic, or for patients who kind of don't want to wait the five years that sometimes we end up waiting to see a geneticist, or a genetic counsellor." (P12, genetic counsellor)*

Others perceived that the benefit of SGT was primarily for individuals outside of a tertiary care centre where genetics services are located.

> *"Yeah, I think that my current experience is that in Canada, if you are a patient, seeing genetics or seeing a tertiary care specialist in a major urban centre, you have pretty good access to genetic testing. If you are outside of that system, I think that that is where sponsored testing is being used currently, and is appealing to providers outside of that system." (P14, genetic counsellor)*

Participants also acknowledged the logistical barriers and bureaucracy around applying for funding faced by their colleagues in other specialties.

> *"In my experience in the Canadian context, these types of programs are very attractive to physicians who aren't regularly accessing genetic testing for their patients, because of some of the current barriers that are in place. And the biggest barrier, I would say, and this does vary from province to province, is the bureaucracy around applying for funding." (P14, genetic counsellor)*

A participant working in industry offering SGT programs had strong opinions on their provincial genetic testing workflow and perceived that genetic counsellors and geneticists were gatekeeping access to genetic testing through patient waitlists. They shared their experience educating non-genetic providers navigating ordering genetic testing in their province.

> *"I think, there's a lot of gatekeeping in genetics right now. I think that genetic counsellors and geneticists have a very tight grasp on who they think should and shouldn't have access to genetic testing, and I think that's wrong and harmful to our population. We can't be gatekeeping people from getting genetic information that could help save their child's life by having a two to seven-year waitlist. That's unethical, and that is not good patient*

> *care…I have the pleasure and privilege of working with and educating and talking to a lot of non-genetics experts, and I'll tell you the number of ways they have tried to figure out how to get around a genetics referral is really disheartening. They make the same case, "I don't want my patient to wait three years to see a genetic counselor," or, "I had a patient that died on a waitlist." Well, of course, you then are going to find a workaround." (P17, genetic counsellor)*

Overall, in provinces where participants perceived restrictions in access to genetic testing, SGT was considered as a work around. This work around was generally used for patients who may not meet provincial eligibility criteria for testing, patients who required test results with a quick turnaround time, patients who are seen by non-genetics healthcare providers, and for participants who did not want to go through burdensome provincial approval procedures to access genetic testing for patients.

3.5 Theme 3: Cost Considerations and Budgets within a Publicly Funded Healthcare System

Interestingly, participants had varying views on how SGT may impact funds allocated to genetics clinics and laboratories. This further influenced their overall perspectives of SGT. Individuals viewed SGT to either have negative implications for funding allocated to genetics laboratories, or viewed it as an avenue to show better patient outcomes from genetic testing, and advocate for the addition of new genetic tests to laboratory test menus. Participants also had varying opinions on how discontinuation of an SGT program would be handled in their institutions. As such, these views took into consideration how SGT may impact current budgets, along with potential downstream impacts.

3.5.1 Fiscal Responsibility

Some participants believed that as healthcare providers working in a publicly funded system, it was their responsibility to assess the cost of all genetic testing options available, including SGT. Their perspective was to try and do what they can to save costs in a struggling healthcare system by offering monetarily free options of genetic testing to patients.

> *"Working in public health care, I really do try to go with the cheapest option all the time. One of the parts of my job I find is I'm always contacting labs and being like, what's your price for this now? What's your price for that now? And making sure I'm going with the best and cheapest tests for people. Just because it is money in public health care, you want to make sure that it's being wisely spent, I guess. I feel I have a duty to make sure it's wisely spent when there's just so much strain on the public health care system right now." (P08, genetic counsellor)*

Participants with the opposite perspective believed that funding should come from the public healthcare system above all other options, as it is the responsibility of the system to provide for its patients.

> *"I do also believe in being a good steward of our budget. We are a socialised health care system, we do not have infinite funds. So, I do want to be respectful of that too. But if we're ordering testing and it's indicated, then we should be allowed to order it, is where I'm coming from. I'm not willy-nilly ordering testing, and I wouldn't expect the province to just fund all these ridiculous ideas or tests – I'm not going to do that – there is responsibility of all of us to be good stewards of the health care system, too. But that doesn't mean that*

> *we just say, 'Well, don't worry about getting the funding.' Because we still ultimately need it." (P10, genetic counsellor)*

Overall, both these participants were cognisant of the limited finances available in the public healthcare pool, but they had different approaches as to whether SGT should be used for the purpose of being a good steward of the budget.

3.5.2 Downstream Impacts

As SGT programs are not indefinite, participants were asked what would happen to patients primarily receiving testing through SGT programs after the program was discontinued. Some participants noted that testing would no longer be guaranteed to be available as it may not be provincially funded.

> *"…I think that's part of the discomfort of our colleagues in the lab, because they warn us that sponsored testing may disappear at any time, which is true, we've seen tests come and go and that if we get used to ordering these tests and they disappear then the public health care system cannot guarantee that they will be available to pick up the slack at that point." (P13, medical geneticist)*

Other participants noted that the availability of that genetic test may decrease, but appropriate genetic tests would be available through the province if indicated, just in smaller volumes. *"I think there would be a push to develop more specific guidelines when a panel should be ordered. And it probably wouldn't be ordered as often, but there would be some situations where it would be ordered." (P03, medical geneticist)*

Participants also argued that clinical utility of a genetic test can be proven through SGT programs, and then expected to be taken on by provincial laboratories once discontinued.

> *"I know there's been a couple of scenarios where we've sent out [sponsored genetic] testing for particular cancers because of a drug and then eventually that was being phased out, but it was expected that we take on that testing." (P02, laboratory geneticist)*

When asked how SGT may impact future budgets, some individuals thought it may act as justification to advocate for increased funding by showing the population's need of that test. One participant commented on how SGT may act as evidence for the need and value of a genetic test not already funded by their provincial funding ministry*. "But that's part of the reason that we do this, because we want to demonstrate that there's a need, and that the public health care system should fulfill this need for our patients." (P13, medical geneticist)*

On the opposite side, there were individuals who perceived that showing better patient outcomes from SGT would not act as enough justification to obtain additional provincial funding, but that it would have the opposite impact and lead funding agencies to believe that the genetic testing currently being funded can be covered by an external party, which could provide a costs savings.

> *"I'm also not ordering it to let the province off the hook either. If people meet provincial funding, I do support that more, mainly because we don't want to get into a situation where if we're ordering all the sponsored tests, so that money is no longer in the budget line. And then the sponsored test goes way, but that funding is no longer there. Because they're like, 'Well, you didn't use this much last year.'" (P10, genetic counsellor)*

One participant shared an example of an interaction with their provincial funding agency who suggested the use of SGT instead of provincial funding for the same gene panel.

> *"I did have a patient who had [condition] and this ginormous panel at [genetic testing laboratory], he really wanted it, but he did not want the sponsored route, he did not feel comfortable sharing his data. So, I applied to the [provincial funding agency] and they did come back and they said, 'Well, this is available sponsored, do you want to talk to the patient about that?' And I wrote back and I said, 'I did talk to the patient about that. They're not comfortable with going the sponsored route,' and they approved it." (P15, genetic counsellor)*

Participants noted that there was a challenge in trying to balance concerns of potential downstream impacts to budgets from SGT, but still taking care of their current patients. One participant commented on how SGT provides a loophole to access restrictions. *"What [SGT] does is provides a loophole around the system, which I think is, I really struggle, because I think it's great for the individual patient, but bad for the system as a whole." (P12, genetic counsellor)*

Some participants also dejectedly believed that even showing benefit of genetic testing from SGT would not be enough to advocate for an increase in genetic funding. They mentioned that not allowing patients to access genetic testing vis SGT due to hypothetical future implications was not good practice.

> *"Do we not allow patients to have access to clinically relevant tests, because we're worried that down the road, it might impact how the province is budgeting genetic testing? You're sacrificing the needs of the patient that's in front of you in the short term for some*

> *hypothetical issue that may or may not be the case in the long term. I know that for every [provincial funding agency] application that I'm not sending in, that that might be giving a misleading indication about the need for this test or the demand for these tests in the patient population here in [province], but on the other hand, to be totally frank, I have had direct communication with people at [provincial funding agency] who are on the other side, and I have implored to them the need for this testing." (P18, genetic counsellor)*

All in all, participants were divided about whether going with a monetarily free option of genetic testing was truly beneficial for conserving provincial funding, and they were also divided on the potential downstream impacts of using SGT. Some perceived that SGT could provide information on the clinical utility of genetic testing to justify increase of the provincial budget and integration of that test, whereas others believed that prolonged use of SGT would take away from the provincial genetics budget by providing a 'no cost' option for certain genetic tests.

3.6 Theme 4: Participants' Perspectives of Non-genetics HCPs Ordering SGT

The themes identified above highlighted CGHPs' perceptions on SGT and the underlying factors influencing these views. In addition to personal influencers, all participants also spoke about their thoughts surrounding the use of SGT by non-genetics healthcare providers. As stated above, participants acknowledged that some non-genetics healthcare providers use SGT to offer genetic testing to their patients. Some participants noted having conversations with other practitioners in their institutions ordering SGT, whereas others had not interacted at all. All participants agreed that there was a lack of genomics education in medical training, and in practice.

> *"So, we need to play an education role, right. And so, it starts off, one, in medical school. Where most medical schools still do not have an integrated curriculum for genetics and that's the ideal place to deal with these issues…So it's a very sort of last-minute approach in terms of trying to educate colleagues at the specialist level. It really should start way, way earlier." (P05, medical geneticist)*

Most individuals interviewed noted considerations for non-genetics providers to keep in mind when ordering genetic testing. When participants were asked about details to share with patients when ordering SGT, obtaining proper informed consent, and ensuring patients were aware that their data may be shared with third-party companies were important.

> *[I usually tell the non-genetic provider to] "Please make sure that you look through the sponsored testing information about how that patient's genetic testing, and genetic information is being utilised and who it's being shared with. So that you can inform the patient, if there's any special consent forms that go with that sponsored testing, the patient should be made aware of that." And the patient should be informed that it is sponsored by a company and how, ultimately, the reason why that company is sponsoring the testing." (P16, genetic counsellor)*

Most participants also found it important for other physicians to provide pre-test counselling for basic information related to genetic testing in general, such as implications of genetic testing, receiving incidental findings, variants of uncertain significance, and potential implications for other family members. When asked what was important for physicians to know when ordering SGT, many participants had similar responses as below.

> *"Basically, everything that will be covered in a pre-test genetic counselling appointment. So, what are the implications of doing this test? What are the possible results we can get? What would the implications of each of those results be? Making sure that patients understand that a negative test doesn't rule out a genetic condition. Making them understand upfront, I think VUS counselling upfront is really important. So, explaining to people before they get their results that VUSs are common. And most of them end up being reclassified as benign…There's also the implications of a positive result. So, what else is associated with that condition? Are other family members going to need to be involved in this? Is there other screening? Is there a possibility of finding a syndromic condition?" (P12, genetic counsellor)*

Moreover, participants cautioned against accepting gene panels at face value, and implored that providers truly understood which genes were on the panel, and whether those genes and methodologies of testing are able to identify the genetic conditions in which they are interested. *"I think it's really just knowing what's on….the panel like what is truly being tested I think is kind of my biggest caution" (P01, laboratory geneticist)*

Participants also talked about the potential clinical burden should there be an influx of genetics referrals to medical genetics departments based on results from SGT. However, they still noted that it was important for the necessary patients to be seen by genetics, regardless of whether they were identified through SGT or otherwise.

> *"We're kind of seeing more and more of these families who have more of a non-classic presentation for certain conditions. So, we're recognising that these pathogenic variants,*

> *maybe have more variable expressivity and lower penetrance than we originally thought…especially as more genes get discovered, and these panels get larger, we're seeing kind of more cascade testing happening for more patients, but at least those are coming through the public system, and it is a strain on the workforce. But I think that that just kind of goes to show that we need more workforce, because these people with these pathogenic variants do need to be followed up on, regardless of whether they were identified through a traditional or a sponsored route." (P12, genetic counsellor)*

Some participants mentioned wishing that the use of SGT was documented in the provincial health system. It was noted that since SGT does not generally go through provincial laboratories, it is difficult to know how many people are receiving genetic testing for a specific indication. This means that the number of tests offered to patients over a period of time are not accurately documented. In turn, this may impact the supply and demand understanding for certain genetic tests, influencing the amount of funding allocated for that test.

> *"We specifically reached out to our send out body to ask how many tests were being sent out for [condition]. And they came back with a very small number of cases, to the point that we didn't think it was worth setting the test up in house, even though we had the ability. And then we became aware of that there was a large amount of testing that was being sent out through sponsored testing. And the concern always is, is that at some point, that sponsored testing will stop and then we'd missed an opportunity to set a test up that we could have." – (P11, genetic counsellor)*

As such, knowledge of which genetic tests were being ordered in a province and how many patients were receiving diagnoses from those tests were desired by this participant, and others.

3.7. Summary

In summary, these results suggest that CGHPs' perspectives on SGT are influenced by their provincial genetic testing processes, values surrounding data sharing, and approaches to being good stewards of a public healthcare budget. As presented above, some participants chose to never suggest SGT to patients, others chose to offer SGT due to challenges in accessing provincially funded genetic testing, and others chose to provide SGT as the primary option or an alternative model to provincially funded testing when available. However, it was evident that regardless of individual stances on SGT, all providers acknowledged that there can be barriers in access to genetic testing including wait times for referrals, wait time to obtain results from genetic testing, burdensome paperwork, and strict provincial eligibility criteria. Participants voiced these concerns as reasons to why both genetics and non-genetics healthcare providers may opt for SGT.

All in all, this data suggests that the information provided about patient data sharing, the desire for workarounds to circumvent public health processes, and cost considerations in a public healthcare system are all factors which influence CGHPs' perspectives on the benefits, limitations, and implications of SGT.

CHAPTER 4: DISCUSSION

This chapter provides a recap of the study, followed by an overview of the main findings compared to existing literature. After that, considerations regarding the use of SGT are suggested. Next, limitations of this study are addressed, along with recommendations for further research related to the topic. Finally, a conclusion will end this chapter.

4.1 Study Recap

This is the first study to our knowledge which applies qualitative interviews to assess the perspectives of CGHPs on SGT. This exploratory study has three primary objectives:

1) Describe CGHP's experiences with SGT.
2) Identify CGHP's opinions on the benefits, limitations, and impacts surrounding SGT.
3) Describe CGHP's perspectives on any impact of SGT within the Canadian healthcare system.

This research allowed participants to share their views on SGT, along with the nuances of using it within a Canadian context. Many participants were ambivalent about the use of SGT in Canada, but most argued that there were perceived benefits and limitations to the use of SGT. Participating CGHPs were divided on whether they used SGT in their practice, along with how they felt about the use of SGT by other healthcare providers in their institutions. Their decisions were influenced by the following themes:

1) Adequate Transparency Surrounding Data Sharing
2) The Desire for a Workaround to Improve Access
3) Consideration of Budgets Within a Publicly Funded Healthcare System

There is a final theme which does not directly answer the study objectives but was consistent amongst all participants. This theme was participants' perceptions about non-genetics physicians using SGT:

4) Non-Genetics Healthcare Providers Ordering SGT

4.2 Consent and Data Sharing in Genomics

4.2.1 Critical Aspects of Informed Consent and How SGT Differs

As showcased in this study, informed consent is a key aspect of the pre-test genetic counselling process. The National Society of Genetic Counsellors (NSGC) outlined the elements of informed consent which should be addressed prior to genetic testing in the field of cancer genetics (Biesecker, 2020). Ten key elements were outlined, including the purpose of the test and whom to test, general information about the gene(s), possible test results, technical aspects and accuracy of the test, economic considerations, the possibility of genetic information discrimination, psychosocial aspects, confidentiality, utilization of test results, and alternatives to genetic testing (Biesecker, 2020).

Some participants from this study did not find the confidentiality and privacy information regarding patient data sharing on consent forms for SGT to be adequate. Patient data shared can include a referring provider, phenotype/symptomology, identifying information such as gender, age, or identity, and genomic data such as variants observed in genes of interest, or raw genomic data. Many participants wished there were more specifics regarding the data sharing processes and what data is shared between the genetic testing laboratory and third-party company sponsoring the test. This included information such as whether the data shared was de-identified,

or whether the third-party company would be receiving raw data or just P/LP variants. Due to the vagueness in the consent forms explaining data sharing, most participants assumed that provider contact and de-identified variant information is the only thing shared with the sponsor. However, one participant in this SGT study shared an experience of a clinical trial directly contacting some of their patients for whom they had conducted pre-test counselling. This participant noted numerous instances where patients with P/LP variants who were eligible for the trial were contacted even prior to a results disclosure session. As such, it was presumed by the participant that identifying patient information was shared with a third-party sponsor organizing the clinical trial, rather than just the de-identified patient results and physician contact. Another participant mentioned sponsoring companies being provided VUS results, and that sponsors would pressure the clinical team of a testing laboratory to identify a way to upgrade a VUS to P/LP and detect potential patients for treatment.

Even so, participants noted that each SGT program was different. Some have more detailed information in their consent form regarding data sharing policies or included partnerships with trusted laboratories from whom participants already ordered genetic testing. Even for participants who were uncomfortable about the vagueness of consent forms in certain SGT programs, they still tended to use SGT programs if it was the only avenue to obtain genetic testing for their patients.

Studies surrounding direct to consumer genetic testing show similar concerns to these participants regarding data sharing and privacy of genomic information. In direct to consumer (DTC) testing programs, such as 23 and me, patients can opt-in to participating in research, and most patients who contribute to research do so willingly (23andMe, 2024). The DTC consent

forms state that third-party companies, such as non-profit organizations, pharmaceutical companies, or academic institutions, may receive data but specifically which third party companies data will be shared with and what conditions will be researched are vague (23andMe, 2024). DTC testing is patient initiated and controlled, compared to SGT where it is the healthcare provider who introduces the genetic test as an option, and data sharing is required. In contrast to DTC, it is the providers' responsibility to inform the patient adequately regarding the SGT programs' data sharing policy.

One participant reflected that as the practice of genetic testing shifts to mainstreaming, the traditional, lengthy model of consent for a genetic test may not be feasible by all providers; however, the basics should still be covered. Similar to existing literature, genetics experts in this study noted that there were a few critical aspects for informed consent in genetics, regardless of which provider is offering genetic test, and whether it is SGT or provincially funded. A study comprised of 25 experts including genetic counsellors, medical geneticists, and experienced bioethicists collated a list of important factors to be discussed for a genetic testing consent (Ormond et al., 2021). It emphasizes the following as important factors of informed consent to discuss with patients: genetic testing is voluntary, the reason for doing the test, when results will be returned, what other types of results may be returned e.g. incidental findings, how this test may affect prognosis and management, how this test may affect other family members, test limitations, and to whom the results will be reported (Ormond et al., 2021). These factors are similar to what the participants of this study observed as critical when offering SGT. Additionally, there is a need to review the unique aspects relevant to SGT programs with patients, too, including data sharing with the sponsoring company and potential future third-parties.

To keep a consent process feasible and efficient for all providers, there is a balance to be found between providing enough information in a pre-test counselling session so that patients can make decisions regarding testing based on their values, but limit detail regarding the complexities of the test, which can affect comprehension or cause unnecessary anxiety (Rego et al., 2020). CGHPs in this study found it challenging to provide balanced information when data sharing aspects of SGT were unclear, with some participants mentioning to patients that their data may be used however the third-party company sees fit, and that there is controversy around SGT programs, but ultimately letting patients make their own decision on whether to opt for SGT when available. Thus, increased transparency regarding data sharing between genetic testing laboratories and third-party sponsors in SGT programs may provide CGHPs with a better understanding of the data sharing agreement and increase their comfort with SGT programs.

4.2.2 Historical Wrongdoings in Genomics and The Emphasis on Consent

The history of wrongdoings in the name of genomics research may provide insight into the background of why genetics experts put a strong emphasis on obtaining informed consent for genetic testing. The history of genetics starts with misuses of genetic data and samples, ultimately causing harm to those whose data was shared, leading to mistrust of the medical community. One of the most famous examples of misuse was in the 1990s with the 'Diabetes Project' where a professor at the University of Arizona was approached to identify potential genetic markers for the high rate of diabetes in the Havasupai Tribe (Pacheco et al., 2013). Unbeknownst to the research participants, there was subsequent research conducted on their data to study schizophrenia, depression, population migration theories, and inbreeding related to the Havasupai tribe (Pacheco et al., 2013). This was done without permission, and research

participants had no knowledge of how this data was being used and shared by multiple academic centers (Pacheco et al., 2013). This violation of trust lead leaders of the Havasupai tribe to banish professors, employees, and any further research from the University of Arizona from their reservation (Pacheco et al., 2013). A Canadian example involves a study conducted by the University of British Columbia for genetic causes of rheumatoid arthritis in individuals of the Nuu-chah-nulth tribe (Dalton, 2002). When the researcher spearheading this project was unable to identify genetic causes for rheumatoid arthritis – the only condition for which consent was obtained to study – they took the samples to the USA and the UK. The blood samples from individuals of the Nuu-chah-nulth tribe were shared with many collaborators and resulted in over a dozen publications (Dalton, 2002). Research published from this data was not related to rheumatoid arthritis, and even included a project on the spread of lymphotropic viruses by intravenous drug abuse within the community, which was a very sensitive topic for the participants (Dalton, 2002). As a result of examples like these and similar events, the value of patient autonomy is stressed in medical genetics training including genetic counselling training programs, and the emphasis of informed consent in genetic testing may be more pronounced than in other specialties. The importance of informed consent is evident in the findings of this study, where some participants noted taking as long as 20 minutes to ensure that information was relayed adequately to conduct genetic testing for a patient when ordering SGT, where data sharing or research was discussed. Participants acknowledged that professionals in non-genetics specialties who also order diagnostic tests for patients do not spend as much time obtaining consent, this may be because those specialties do not have or emphasize similar histories regarding the misuse of patient data.

4.2.3 Informed Choice and Patient Autonomy

In historic medical practices, ethics did not include an appreciation for a patients' right to consent for medical treatment (Beauchamp, 2011). Tests and procedures were conducted on individuals based solely on physician recommendation, without explanation of potential stressors or harms on patients (Beauchamp, 2011). While other healthcare professions offer diagnostic testing to patients, most participants in this study noted that the process of consent when it comes to genetic testing has unique implications that distinguish it from other tests which healthcare providers may not recognize. Medical informed consent ensures that patients understand the procedure or test being offered, understand any risk and limitations, have the capacity to make decisions and choose to proceed voluntarily. Genetic counsellors and geneticists have the skill set to facilitate consent for genetic testing, given all the complexities unique to this type of test, for example, incidental findings or implications for family members (Rego et al., 2020). In a genetic counselling setting, obtaining informed consent may include a discussion between the clinician and patient surrounding the utility of a genetic test, the limitations, benefits, and ensuring a patient can opt out. Following this, a genetics provider and patient may sign a form stating that consent is given for a genetic test to proceed (Rego et al., 2020)

Some participants in this study reported offering SGT to patients as an option when available, stating that it was the patient's choice about whether they choose to pursue and consent to an SGT program. Interestingly, in a recent study of the general public in Australia, individuals noted controversial feelings around sharing genomic data with pharmaceutical companies and profit-driven organizations (Lynch et al., 2023). The publication reported that participants experienced more anxiety sharing data with private companies but recognized the dual nature of the benefit

of data being used to create or study new therapies (Lynch et al., 2023). Another study showed that the public tends to have reservations when it comes to data sharing with for-profit research organizations due to distrust regarding the potential motives and ethics of the organization (Trinidad et al., 2010). However, literature also shows that patients can be advocates for facilitation and participation in clinical trials (Geißler et al., 2022). These examples hold similar to some of the experiences highlighted by participants in this study who have spoken with their patients about SGT. Participants stated that patients were either eager to participate in programs where their data could be used to research new therapies, or concerned due to distrust about data sharing with for-profit organizations.

A survey in 2013 demonstrated that the Canadian public has varying levels of acceptability when it comes to interactions between physicians and pharmaceutical companies (Holbrook et al., 2013). The public seemed more accepting of these interactions when physicians were requesting information about a drug, but acceptance was low for interactions involving recruitment fees for trials (Holbrook et al., 2013). From our understanding, SGT programs do not generally offer physicians compensation for recruiting patients into programs, and discussions between physicians and pharmaceutical companies concern identifying eligible patients for therapies.

4.2.4 Rules and Regulations on Data Sharing

Neither the USA nor Canada have specific laws governing all types of genomic data sharing. As mentioned in the introduction, both countries have laws governing protection of personal health information and medical documentation in general. In Canada, each province has its own version of a health privacy act such as PHHIPA or PHIA, which is designed to address issues concerning collection, use, and disclosure of health information (Cavoukian & Grant, 2004). Specific guidance

regarding health laws, such as what documentation is protected, and restrictions or limitations, are provincially regulated. In the USA, Health Insurance Portability and Accountability Act (HIPPA) regulates the exchange of personal health information between physicians, hospitals, testing facilities and insurance companies to fulfill services for a patient (Sklar, 2020). Genetic testing laboratories which are HIPAA regulated must comply with HIPAA's necessary minimum standard, which applies to the use, requests for, and disclosure of personal health information (Evans & Jarvik, 2018). However, it is not a requirement of all genetic testing laboratories to be HIPAA regulated. Personal health information transferred to another country is subject to the laws of that country (Office of the Privacy Commissioner of Canada et al., 2017). As such, Canadian patient samples sent to the USA for genetic testing are subject to the USA's data sharing and privacy laws, and regulated under laboratories which may be HIPPA compliant. As one participant noted in this study, this is true for provincially funded genetic testing being sent to the USA as well. However, those tests are generally not shared with third party companies.

The above discussion suggests that the history of misuse of genomic data has shaped genetics professionals' approach to informed consent. Some individuals believe genomic data should be treated differently than other medical data due to unique considerations such as the possibility of re-identification. Acts such as PHIA and HIPAA regulate privacy and sharing of medical information, including genomic data, and apply to medical professionals and regulated laboratories. SGT programs generally share patient data between the genetic testing laboratory and third-party sponsor, as described and permitted on the consent signed by the provider or patient. However, some CGHPs find the information surrounding data sharing in the SGT programs vague, since details about who has access to data, and what type of data is shared are not always

specified, which can be reminiscent of the history of misuse of genetic data. As such, some CGHPs desired more information to properly understand the data sharing agreements.

4.3 Workaround

4.3.1 Provincial Laboratory Funding

In Canada, genetic testing can either be conducted in local laboratories situated in hospitals, or by larger, commercial laboratories across the country or in other countries. Healthcare is a provincial responsibility, where each province determines their own expenditure priorities, including funding for clinical genetic programs and testing laboratories. Decisions on whether to fund and approve genetic testing to be sent to these external commercial laboratories is at the discretion of each provinces' funding agency or decision-making body (Christian et al., 2015). Individuals involved in such decisions include medical geneticists, and laboratory directors.

In this study, some participants mentioned taking into account provincial budgets when deciding to use SGT as a workaround. This was either because they felt a fiscal responsibility to save public funds, or they felt that their request for a patient's genetic test would not be approved by their provincial funding agency but could be accessed through SGT.

In a 2009 study by Adair et al., senior lab directors and medical geneticists were interviewed and questioned regarding processes for predictive genetic testing funding allocations—they reported two funding models. In some provinces, funding is provided to hospitals or regional centers who then allocate funds for each test. The second funding model reported in Canada involves funding granted directly from the ministry of health to the genetic testing laboratory. In a 2009 study, most participants described a collaborative approach between laboratory directors and clinical

heads in fund allocation for a particular test, although they reported some variation between provincial systems which were influenced by whether services were centralized or covered by multiple centers (Adair et al., 2009).

A Canadian study looking at out-of-centre referrals across all provinces noted differences in approval processes. In four Canadian jurisdictions, genetic testing being sent to an external laboratory can only be requested by a medical geneticist (Christian et al., 2015). Five Canadian jurisdictions have a separate budget for genetic testing, and perceived cost as important in the decision making and approval process for genetic testing. In the study by Christian et al. in 2015, the authors reported that one third of their participants (senior laboratory geneticists) interviewed from provinces without an independent genetics budget reported cost as an important consideration when approving a specific referred out genetic testing request (Christian et al., 2015).

The differences in provincial approval processes align with differences perceived by participants in this study regarding whether or not they used SGT. Individuals from provinces with centralized service systems which were perceived as being restrictive mentioned needing to use SGT, individuals from provinces with centralized service systems which did not view genetic testing budgets as restrictive refrained from using SGT, and providers from provinces which had decentralized service systems had varying responses regarding their use of SGT.

Unlike the Canadian health service systems, in the United Kingdom (UK), healthcare is a national service and the National Health Service (NHS) has criteria for eligibility, testing guidelines and funding of molecular genetic testing accessible through the national genomic test directory

website, which is the same for all countries in the UK (National Health Service, 2000). The Adair et al. 2009 study inquired whether national standards would benefit the Canadian system. While many participants agreed this would be beneficial for standardization, they recognized the difficulty of coordinating and implementing a similar process as the NHS. In the results of this SGT study, participants from certain provinces were more likely to view genetics budgets as restrictive and use SGT as a workaround. A national approach to guidelines for which tests should be funded may decrease the provincial gaps in access for genetic testing and differences in practice identified by participants.

4.3.2 Clinical Utility

Participants in this study who mentioned using SGT as a workaround tended to perceive their provincial genetic testing menu and criteria, or referred out process, as restrictive or limiting.

Using SGT to provide access to genetic testing can be seen in the United States of America (USA) as well, with SGT being used to access genetic testing for patients whose insurance does not cover the financial cost of the test (Larson et al., 2023).

Within the publicly funded Canadian system, one individual reflected on their provincial funding being behind the need of the rapidly evolving genetic testing technology. In addition, they commented on how other provinces have more funding to access genetic tests as needed, creating different standards of care across Canada, and leading them to make use of SGT programs to access genetic testing for patients. In contrast, participants who did not regard the need for a workaround in their respective provinces disagreed about using external avenues to obtain genetic testing, as they believed that it was the responsibility of the public healthcare

system to adequately allocate funds, and that their responsibility was to hold the healthcare system accountable for all patients, rather than finding workarounds.

4.3.3 Timelines

Logistical factors such as turnaround time to results was stated as a benefit of SGT by many participants. Turnaround time from larger commercial laboratories tends to be quicker than local genetic testing due to the higher volume of test requests received by commercial laboratories. Even when provincially funded genetic tests are sent to external laboratories, this avenue may require a wait time to approve the test by the funding agency before it is sent away. As such, SGT can be quicker as the process of approval is not needed. Expedited requests for genetic testing in pubic Canadian laboratories can be completed between 3-6 weeks, and non-expedited requests can take several months to complete (Selvarajah et al., 2022). This is contrasted with larger genetic testing laboratories where expedited genetic tests can be conducted within 2 weeks, and regular orders can be completed between 3-7 weeks for large panels and even exomes. This seems in line with challenges noted in the literature of Canadian laboratories not having enough funding to provide complex testing services or having the adequate equipment, test validation budgets, laboratory technologists, bioinformaticians, and clinical laboratory scientists to expand in-house genetic testing services and offer quicker turnaround times for genetic tests. (Selvarajah et al., 2022). A participant in this study shared the reason as to why their local laboratory opted to house an SGT program. Similar to the reasons above, this participant remarked that collaboration with large, commercial laboratories allowed their in-house genetic testing laboratory to receive funding to validate new equipment and develop testing that may not have otherwise been available.

Thus, there are differences in timelines and budgets for genetic testing between provinces which lead some providers in this study to opt for SGT as an avenue of genetic testing when they needed a workaround to circumvent their provincial process.

4.3.4 Logistical Barriers

Provincial processes for approving referred out genetic testing were identified as a logistical barrier by some participants. Literature showed that nine genetic testing jurisdictions across Canada require formal applications for funding approval (Christian et al., 2015). These logistical barriers may also be exacerbated for non-genetics healthcare providers trying to order genetic testing, as they may be less familiar with the nuances and multiple steps of this process (Christian et al., 2015). This idea was shared in literature studying non-genetics physicians' barriers to ordering genetic testing, with bureaucracy and paperwork reported as an intimidating aspect of the procedure (Bonter et al., 2011). In this SGT study, a participant reported their preference of using SGT to circumvent the provincial application process and additional paperwork, which they viewed as redundant and time consuming.

Interestingly, some of the barriers that non-genetics healthcare providers face when ordering genetic testing seem to be institutionally specific, as presented in the publication by Bonter et al. 2011 on personalized medicine in Canada. This study describes challenges reported by oncologists, cardiologists and family physicians when interacting with genomic medicine, such as limited knowledge on which genetic tests they are able to order, lack of practice guidelines for pre- and post-test counselling, and challenges navigating required paperwork for their institutions, like genetic testing requests (Bonter et al., 2011).

Some participants in this study considered the ease of ordering SGT, with the company mailing the saliva kit directly to the patient and the specimen shipping being covered by the SGT program – thereby, completely circumventing the provincial laboratory. Additionally, some individuals described SGT forms and requestions as being less time consuming to complete than referral forms to request provincial approval for funding of a test. An example of the desire to circumvent the provincial restrictions involve cases where follow up testing on a patient is not permitted. As one participant provided an example, in some provinces, if a patient has a large genetic panel and negative test result, a provider is unable to order a more comprehensive test, such as an exome, right away and must wait a few years. If the provider orders the same genetic panel through a SGT program and the result is negative, they are able to order an exome using provincial funding without the waiting period.

Some SGT programs offer genetic counselling services to patients, and genetics expertise to non-genetic healthcare professionals ordering these tests. These SGT genetic counselling services are able to describe the benefits or limitations of the test ordered, and how a variant is classified, but are generally limited in their ability to interpret the genetic results as it relates to the patient's clinical presentation. The gap in what SGT genetic counselling services scan provide versus what provincial genetic counselling services can provide may be due to the fact that the SGT genetic counselors have not consulted the patient and may have limitations in the support they are permitted to offer to providers as a result. In addition, SGT genetic counsellors may not be able to assist Canadian healthcare professionals on their hospital systems and referral processes for their institutions or province.

4.3.5 Downstream Provincial Budgets Impacted by Sponsored Genetic Testing

Results from this study identified that participants were thinking about whether SGT could result in a decrease of genetics laboratory budgets due to perceived lack of local need or interest in a specific test. Other participants thought that SGT could lead to evidence of clinical utility that could be used to advocate for new genetic tests on the laboratory test menu. Interestingly, downstream implications played a part in participants' decisions on whether they offered SGT to their patients. However, most participants recognized that the concerns regarding downstream implications were hypothetical concerns, as most had not seen any downstream budget changes due to of prolonged SGT use. Since these providers were not privy to specific information regarding local or provincial genetics laboratory budgets, some felt that they could not make an informed opinion on the downstream impact of the SGT as a result. Interestingly, in Christian et al., 2015, where the senior laboratory individuals interviewed were involved in referred out funding decisions across Canada, many participants were hesitant to provide specific budgetary information about their province. Those who shared their budgets demonstrated variability that was only partially explained by populations size by province (Christian et al., 2015).

SGT study participants expressed a desire for increased transparency surrounding provincial genetic testing budgets to determine how the use of SGT may influence these budgets in the future. It is notable that regardless of potential downstream implications, participants mentioned that it was more important to think of the patient they are seeing in the moment, rather than thinking about the future consequences of SGT. As such, even participants who were concerned about potential negative implications to genetics budgets through the use of SGT offered it to patients if it was the only avenue to obtain genetic testing.

Thus, hypothetical downstream outcomes on how SGT may impact genetic budgets were described by participants as important considerations to how they perceived SGT, and many participants considered themselves stewards of the public healthcare system.

4.4 Clinical Pathways to Obtaining Genetic Testing

4.4.1 SGT as a Pathway to Mainstreaming

The topic of non-genetics providers using SGT to access genetic testing for their patients was discussed by participants in this study. As presented above, some provinces restrict genetic testing to be ordered by medical genetics, at least for some specialized tests. Therefore, the current landscape of waiting for genetics departments to examine patients leads to very lengthy wait times. As a result, non-genetics physicians may opt for SGT so that they can access genetic testing for their patients without putting them on a long waitlist. Some CGHPs in this study had concerns with non-genetics physicians ordering SGT but understood their desire to access genetic testing through SGT instead of waiting for medical genetics evaluation. As such, lengthy wait times to see genetics specialists, alongside the gatekeeping of genetic tests in some provinces, seem to steer non-genetics providers to ordering genetic testing through alternate routes like SGT.

Interestingly, many of the recommendations and suggestions by CGHPs to non-genetic providers regarding ordering genetic testing were not unique to SGT but should be implemented for all genetic test orders. Literature on mainstreaming states that there are important factors for pre-test counselling sessions which should be integrated efficiently in mainstreaming services. These factors include discussions around anticipated results (P/LP/VUS), the potential impact of results on medical management and family members, psychosocial impacts of a genetic diagnosis, and

to give the patient an opportunity to opt out of genetic testing (Bunnik et al., 2021). Preparation for all these possibilities should ideally be done during the pre-test counselling session. Participants in this study had similar concerns, where they expressed worry about situations where non-genetic healthcare providers were ordering genetic tests without considering the impact that genetic testing can have on a patient. SGT is generally marketed by the clinical laboratories' representatives towards non-genetic healthcare providers, mirroring aspects to that of mainstreaming. Unlike provincial mainstreaming initiatives where local laboratories and clinical genetics programs usually assist with provider education and implementation, providers ordering SGT may not have easy access to local genetics specialists to assist them in learning crucial pre-test discussion points and result interpretation as it relates to their patient's symptoms. Furthermore, provincial mainstreaming initiatives are generally supported by increases or restructuring of the genetics workforce to accomplish the required support, whereas the Canadian healthcare system would not be able to anticipate the needs coming from SGT as it is outside the provincial workflows.

4.4.2 Workforce Shortages

There is an overall paucity of genetics workforce in Canada. On average, there are 1.28 (range: 0.00–2.44) genetic counsellors for every 100,000 individuals in Canada (Lambert et al., 2022). There are even fewer geneticists across Canada, with a recent estimate in 2019 being a total of 111 practitioners, according to the Canadian Medical Association (Lambert et al., 2022).

Some participants in this study expressed concern regarding the potential increase of referrals to clinical genetics due to increased use of SGT by non-genetic providers. The type of referral received could be for genetic counselling of patients with P/LP results, or requests for cascade

testing of family members. In addition, referrals would include review of VUS in genes not related to the patient's symptoms that could be dismissed. Most participants noted that it was important to identify patients with significant variants, even if the testing method is via SGT, and that it was unfortunate that this may result in additional strain for genetics clinicians. As such, there is a possibility that an increased volume of referrals due to results from SGT could exacerbate the existing resource challenges faced by medical genetics clinics across Canada (Lambert et al., 2022).

4.4.3 Considerations for Genetic Testing Versus SGT

Panel curation is a process which takes into account which genes to include on panels for maximal clinical utility, while trying to minimize unnecessary burdens such as unsolicited findings (Bean et al., 2020). In SGT panels, the gene curation may differ, as panels created may be influenced by the SGT program, including candidate genes, or specific genes of interest for new therapies or trials. There is also limited disclosure regarding the SGT process of panel curation. Furthermore, some SGT panels can be larger than those available through a provincial funded system, which increases the potential for finding a VUS result. Larger panels can result in negative psychosocial impacts or distress to patients, especially if pre-test counselling did not adequately cover all the important aspects from genetic testing as presented previously (Bean et al., 2020; Bell et al., 2023). These considerations were discussed by many participants in this study regarding the use of SGT by non-genetics providers, and are echoed in literature regarding mainstreaming.

Results from this study determined that there were also considerations for all providers to keep in mind which are unique to the ordering of SGT. Some CGHPs wished that the volume of SGT being conducted by all providers was documented, along with the diagnostic yield of those tests.

This is because some participants believe that showing clinical utility from SGT could help advocate for inclusion of that test to be funded or incorporated within the provincial laboratory test menu in the future. Other considerations unique to SGT as stated above would include understanding the data sharing agreement between the genetic testing laboratory and sponsoring third-party company due to the nuances, such as reidentification, of genetic information compared to other medical information.

4.5 Final Considerations

This study offers insights into CGHPs' perspectives on SGT. From this data, considerations have been derived to suggest responsible and informed engagement of SGT, with recommendations or suggestions outlined for various stakeholders (Table 7). Considerations for genetic testing laboratories and sponsoring companies include being clearer about their data sharing policies and agreements. This includes stating whether patient data is de-identified, with whom the data is shared, for what types of research this data will be used, and whether future data sharing agreements are also incorporated within current consent. Considerations for all clinicians include ensuring that patients are informed that they are receiving a sponsored genetic test, and how this differs from a provincially funded diagnostic test. Furthermore, there is a call for increased communication between genetics and non-genetics physicians surrounding how to navigate institutional processes for genetic testing, and a recommendation that all providers document the volume of SGT ordered, along with the diagnostic yield. Lastly, considerations uniquely for non-genetics physicians ordering genetic testing include familiarity with key aspects of a pre-test counselling session, such as obtaining consent for genetic testing, describing possible results from a genetic test, and implications for patients and family members, along with understanding how

to interpret test results. Lastly, considerations for provincial funding agencies/laboratories include increased transparency about genetic testing budgets, and how budgets may be impacted by use of SGT.

Table 7: Considerations Towards Informed engagement of SGT for Stakeholders

Considerations for Laboratories and Sponsoring Companies
1. A call for increased transparency regarding data sharing policies and agreements between genetic testing laboratories and sponsoring companies. Suggestions include: - Describe how and whether patient data is de-identified - Mention with whom data will be shared (e.g. sponsors, other 3rd parties) - Clarify for which purposes data will be used - Describe how patient data is stored and the retention period when transferred to sponsoring companies and third parties - If consent involves broad data sharing in present and future, it should be explicitly stated
Considerations for all Clinicians
2. Ensure patients are making informed decisions about their participation in SGT programs through offering all possible options for genetic testing available
3. Improve/increase communication between local genetics professionals and non-genetics providers for a better understanding of provincial processes and when SGT is appropriate
4. Canadian institutions or departments using SGT should document volumes of SGT ordered and diagnostic yield
Considerations Specifically for Non-genetics Clinicians
1. Ensure patients are making informed decisions about their participation in SGT programs through pre-test counselling. Discussion suggestions include: - Describing that data will be shared with sponsoring companies as per the consent (unique to SGT) - The reason for doing the genetic test - Possible results from a genetic test (P/LP, VUS, B/LB or incidental findings) - Possible implications for family members - Clarifying that patients can refuse a genetic test and have the right 'not to know'
5. Understand interpretation of genetic test results
Considerations for Provincial Funding Agencies/Leaders
6. Increased clarity from provincial funding agencies regarding potential downstream impacts to genetics budgets as a result of the prolonged use of SGT

4.6 Limitations

This exploratory study regarding CGHPs' perceptions on SGT aimed to sample a diverse set of CGHPs across Canada. This study achieved interviews from three medical geneticists, three laboratory scientists, and 12 genetic counsellors. This sample of 18 individuals cannot be generalized to determine perspectives of SGT from all CGHPs across Canada. While we discussed provincial restrictions as challenges, it is important to note that some provinces, like Ontario and British Columbia, have many centres offering genetics care and have multiple laboratory systems, meaning that genetic providers' perceptions on SGT working under different systems within the same province should not be generalized as being similar.

Additionally, participants were sampled across six provinces. There are currently eight provinces which have a medical genetics department and local genetic testing services. Patients in Prince Edward Island, New Brunswick, Yukon, Nunavut, and the Northwest Territories are generally seen by genetics providers located in other provinces. We were unable to recruit any CGHPs from Quebec or Nova Scotia.

This sample may be limited by participant-selection bias since individuals who opted to participate may have a stronger interest in this topic. Distinctions in the results could not be made based on specialty, as many of the genetic counsellors and geneticists interviewed practiced in multiple specialties at once. Moreover, this study data is based on the current landscape of genetics service delivery in Canada, and the current availability of SGT. Service delivery models and SGT program availability may change over time.

The results and discussion section of this paper mentions CGHPs' views on other providers' and patients' interactions with SGT. However, this study is limited as the population does not actually include perspectives from those stakeholders.

4.7 Future Directions

This study has provided valuable insight into the viewpoints of CGHPs on SGT in Canada, including benefits, limitations, and potential downstream implications within a public healthcare system. However, as this is an exploratory study, there are still many areas within this topic which require further exploration. Further research on this topic requires input from multiple stakeholders, including non-genetics professionals, and patients.

A survey capturing both genetics and non-genetics healthcare providers surrounding their use of SGT, and their perceptions on the benefits and limitations can reach a broader audience and offer a better outlook on the use of SGT across Canada, and across specialties.

Research on the perspectives of patients who have undergone SGT should also be explored. At this point, providers who are making decisions on whether to offer SGT to their patients are not informed by patient preferences. Understanding patients' perspectives and preferences about being offered SGT, and what information they find important to make an informed choice would be valuable in helping providers refine and target their discussions about SGT with patients.

Finally, various points were discussed throughout this study surrounding a lack of genetic knowledge in non-genetics professionals and different comfort levels with genetic testing. As such, research understanding medical school training on genetics, along with what continuing education opportunities are available for physicians in Canada to improve their genetics

knowledge would be appropriate, especially given the increased access to genetic testing for non-genetics specialists, both through mainstreaming programs and SGT.

CHAPTER 5: CONCLUSION

To date, there is no research surrounding the use of SGT in Canada, or how it is perceived by professionals. Due to this gap in research, semi-structed interviews were conducted with 18 CGHPs across six provinces to offer insights surrounding their perspectives CGHPs on SGT. Four main themes were highlighted 1) adequate transparency surrounding data sharing 2) the desire for a work around to improve access 3) consideration of budgets within a publicly funded healthcare system and 4) perspectives of non-genetics providers ordering SGT. Participants shared a spectrum of views for many of the themes.

Proponents of SGT noted satisfaction with data sharing information provided by SGT companies, believed that SGT provided increased access to genetic testing, and that positive patient outcomes from SGT may help justify increased provincial funding of genetic services. Skeptics of SGT noted that there was a lack of transparency regarding how patient data was shared, that the public healthcare system had a responsibility to cover all patients who require genetic testing, and that there was a need to consider how external testing could be detrimental to future budget considerations through providing no cost options. All participants had considerations for their non-genetics colleagues ordering SGT. Considerations for healthcare providers, sponsoring companies, and provincial funding agencies across Canada arose from participant responses.

All in all, this research demonstrates the benefits and limitations of the expanded availability of SGT in Canada, along with a unique perspective into the nuances of using SGT within a publicly funded healthcare system. Our findings warrant further investigation surrounding other stakeholders' perspectives on SGT, such as non-genetics physicians and patients.

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APPENDIX

Appendix A: Invitation Email/E-blast

INVITATION EMAIL/ E-BLAST TEMPLATE

SUBJECT: Exploring genetic healthcare providers' perceptions on sponsored genetic testing

Dear Colleagues,

My name is Daena Hirjikaka, and I am a MSc Genetic Counselling student at the University of Manitoba. I am reaching out to recruit participants for my study titled **"Exploring genetic healthcare providers' perceptions on sponsored genetic testing."** This study is part of my MSc Genetic Counselling thesis project.

Study Description: The goal of this study is to interview a variety of genetics healthcare providers (medical genetics, laboratory scientists, genetic counsellors) to explore their experiences and opinions on sponsored genetic testing for inherited monogenic conditions. Your participation will help us better understand the benefits and limitations of using sponsored genetic testing, particularly in relation to the Canadian healthcare system, along with provide a starting point for further research on this topic.

You may be eligible to participate in this study if:

- You are a healthcare provider working in Canada
- Are a certified genetic counsellor (ABGC or CAGC) OR
- Are a certified medical geneticist or laboratory scientist (CCMG or equivalent)
- You are proficient in English

Please feel free to forward this email on to any individuals that may meet the eligibility criteria in your clinic or network.

Your Role: We hope to learn more about your experience, perspectives, and opinions on sponsored genetic testing through a 30–45-minute interview. If you are interested in participating in this study, please respond to me by email at hirjikad@myumanitoba.ca to indicate your interest. Once we hear from you, a link to a two-minute online questionnaire will be sent to help gather some preliminary information about you and your interaction with sponsored genetic testing, which will be used to tailor your interview.

I look forward to hearing from you.

Sincerely,
Daena Hirjikaka

Appendix B: Interview Guide

INTERVIEW OUTLINE

[Introductions and Rapport Building]

[Review Informed Consent Form]

[Begin interview once verbal or written consent obtained]

Thank you again for agreeing to participate in this interview. I will be asking you a range of questions.

Please feel free to let me know if you would prefer not to answer a question, or if you would like to take a break at any time.

Please try and refrain from stating identifiers like your own name, colleagues names or name of the clinic you are affiliated with etc.

SGT for inherited monogenic conditions we aren't looking at SGT for somatic testing Examples of SGT would include the Behind the seizures program or TTR Amyloidosis Compass program

[turn on Zoom captions and record]

INTRODUCTION QUESTIONS *(To build rapport and increase comfort answering questions)*

I'd really like to learn a little bit more about you. Can you tell me a bit about your current role?

- Prompt: *What do you do in your current role?*
- Prompt: *How long have you been in your current position?*
- Prompt: *How long have you been practising?*
- Prompt: *Did you work in a different role/position prior to this*

Just a quick recap for the study is that we are looking at considerations surrounding SGT from the perspectives of genetics professionals in Canada and that's what the conversation will be centred around

Topic 1: Experiences with Sponsored genetic testing (SGT)

Experiences with SGT

- I wanted to start off by asking what your general impression or thoughts are on sponsored genetic testing
  - *Prompt: are there situations where it is more appropriate to order SGT vs not*
  - *Example or scenario of this situation you've encountered, step by step if able*

- What interactions with SGT have you had in your practice/ how have you been using it?
    - Prompt: *Have you been ordering it yourself? What does that process of ordering look like for you? Step by step example, if applicable*
    - Prompt: *Have you had any discussions about SGT with colleagues, or heard about it in conferences?*
    - Prompt: *Have you consulted with other HCPs who order it? What does that process for consulting look like for you?*
- In addition to your interactions with SGT, are you aware of non-genetics HCPs ordering SGT and if so, what do you think about that?
    - Prompt: *Do specialists consult genetics when ordering SGT or after receiving results?*
    - Prompt: *Do you think they should consult genetics, and if yes, when and how should genetics HCPs be supporting non-genetics HCPs when it comes to ordering SGT?*
    - Prompt: *How do patients receive results and get downstream management?*
    - Prompt: *What are your thoughts about workload or waitlists for genetics teams when it comes to SGT*
    - Prompt: ~~*Can you describe to me what you find concerning about non genetics HCPs ordering SGT? Specific example or case which you've encountered?*~~
    - Prompt: what are some considerations you would provide for non-genetics HCPs ordering SGT?

Topic 2: Benefits and Limitations of SGT

- What do you think are the potential benefits of SGT?
    - Prompt: *Do you think the use of SGT is cost-effective,* ~~*when compared billing the public healthcare system,*~~ *is this a means to promote collaboration with industries and the public sector, is turnaround time worth opting for SGT, ending of diagnostic odyssey, increased access to genetic testing, does SGT improve access to therapies/research trials, how do patients respond to the option of SGT?*
- What do you perceive as the limitations of SGT?
    - Prompt: *Do you see data privacy and the use of third parties as a concern, data storage policies up to par, do you think that patients have a god understanding or knowledge/consent of genetic testing through this process?*
    - Prompt: *Part of the SGT process is that sponsoring companies can contact the ordering provider, have you been contacted by a sponsoring company regarding any of your patients? What was that experience like?*
    - Prompt: *Are you always aware if another provider has ordered SGT on your patient/does it go into the EMR genetics uses?*
    - Prompt: *What would happen if an SGT was suddenly taken away?*

Topic 3: Impacts of SGT in the healthcare system

- Does your institution or department have any policies (official or unofficial) regarding the use of SGT?
    - Prompt: *If yes, what are some of those policies*
    - Prompt: *If no, do you think that policies need to be implemented?*
    - Prompt: *Why did the department feel the need to implement these policies?*
- Via what processes should SGT be offered in public institutions in Canada?
    - Prompt: *How is SGT being integrated into the healthcare system/in your clinic or institution?*
    - ~~Prompt: *Are you managing SGT and what impacts are you feeling from that?*~~
    - Prompt: *Potential downstream workforce/resource issues from more SGT results being referred to genetics*
    - Prompt: *Are there any changes that could be made to address the concerns we've talked about regarding SGT within the healthcare system? (e.g. education for non-genetics HCPs, guidelines for use)*
    - Prompt: *Do you see any gaps or needs in the public healthcare system which SGT is filling and what are those gaps? Do you have any concerns around SGT filling this gap? (e.g. inconsistency in some providers ordering SGT vs. not)*
    - Prompt: *In your perspective, are there specific circumstances where it is appropriate to offer SGT vs. when it isn't, and what are those circumstances?*
- So, for example, if there were a SGT which was going to be implemented in your practice, what would you want the implementation process to look like?
    - Prompt: *E.g. different workflows re: testing ordered via SGT?*
    - Prompt: *Considerations as to when to order SGT vs. not*
    - Prompt: *Management of pharmaceutical company representatives for treatment of patients – who do they contact if the patient is eligible for a treatment?*
- Do you find SGT is a way to provide justification for funding of more/certain genetic tests?
    - What are the potential negative or positive downstream budget impacts from increased use of SGT?

Ending interview

- Is there anything that we didn't touch on that you would like to bring up?
- Do you have any colleagues who you think would be good candidates to participate in this study?

[Conclude interview]

If you have any other questions about this study or how the information you shared will be used, please don't hesitate to contact me by phone or email, my contact information is on the consent form.

Appendix C: Consent Form

University of Manitoba

Rady Faculty of Health Sciences
Max Rady College of Medicine
Biochemistry and Medical Genetics

CONSENT FORM FOR PARTICIPANT
Individual Interview

Study Title: ***Exploring genetic healthcare providers' perceptions on sponsored genetic testing***

Student Investigator: Daena Hirjikaka, BSc CGC **Supervisors**: Claudia Carriles Landry, MS,

You are being asked to participate in a research study involving an individual interview. Please take your time to review this consent form and discuss any questions you may have with the study staff before you make your decision. Please ask the study staff to explain any information you do not clearly understand in this form.

The student investigator for this study is Daena Hirjikaka, an MSc student in the genetic counselling program at the University of Manitoba. This research study is being completed as part of the student investigator's MSc Program. The project supervisor for this study is Claudia Carriles Landry, a board-certified genetic counsellor and the associate director of the genetic counselling program at the University of Manitoba.

PURPOSE OF STUDY

This study aims to explore the experiences and opinions of Canadian genetic healthcare professionals on sponsored genetic testing for inherited monogenic conditions. We to hope to better understand the benefits and limitations of the integration of sponsored genetic testing within Canada, and genetics providers' outlooks on this testing model. We hope the study results will provide an understanding on the impacts of sponsored genetic testing within the Canadian healthcare system, along with provide a starting point for further research on this topic.

PARTICIPANT SELECTION

You are being invited to participate because you have identified yourself as a genetics healthcare provider working in Canada. You can participate in this interview if you speak English AND:

- ✓ Are a certified genetic counsellor (ABGC or CAGC) OR

- ✓ Are a certified medical geneticist or laboratory scientist (CCMG or equilvalent)

STUDY PROCEDURES

- The answers to your online screening questionnaire completed prior to the interview may guide some questions in this interview. We are hoping a total of approximately 24 participants will complete an interview
- The interview will be conducted over University of Manitoba Zoom (UM Zoom) by the student investigator, Daena Hirjikaka. The interview will be approximately 30 – 45 minutes in length
- You will be asked questions about your experiences and opinions on the use of sponsored genetic testing in Canada
- These questions will help us better understand the benefits and limitations of sponsored genetic testing, along with help us understand the landscape of sponsored genetic testing within Canada, as there is currently no research on this topic
- Interviews will be audio recorded and the audio recordings will be transcribed by the student investigator or by a confidential transcription service to ensure accurate reporting of the information that you provide. The student investigator may also take notes during your interview
- The transcription service will sign a form stating that they will not discuss any item on the tape with anyone other than the study staff
- Individual results and interview transcripts will not be provided to you

POTENTIAL RISKS

There are very few risks to participating in this study. It is possible that talking about your experiences might be upsetting, emotional, or distressing for you. You do not have to answer any question that makes you feel uncomfortable or that is upsetting. We will do our best to maintain confidentiality. However, because the field of genetics is small within Canada, absolute anonymity cannot be guaranteed. As UM Zoom will being used for interviews, the researcher cannot guarantee complete privacy of the data collected through this medium.

BENEFITS

There will be no direct benefit to you from participating in this study. We hope these study findings will be used to understand what the benefits and limitations are regarding sponsored genetic testing, and create suggestions or considerations for professionals using this testing method.

COSTS

There is no cost to you to participate, aside from the time it takes to conduct the interview.

SAFETY

Your confidentiality may be broken if you describe one of the following:

- You say something about harming yourself or others
- You tell me about the abuse or neglect of a child
- You report inappropriate or incompetent practice of a healthcare professional

CONFIDENTIALITY

Your online screening questionnaire will be linked to your interview by a de-identified participant ID. This will allow us to use your questionnaire to inform and tailor your interview ahead of time. We will do everything possible to keep your personal information confidential. Your name will not be used at all in the study records. All participant information will be kept in a secure file in case we need to contact you with regards to the study. All identifying information (names, pronouns, clinic name) will be removed during the transcription process of your interview. Please note that although you will not be identified as the speaker, your words may be used to highlight a specific point. Collection and access to personal information will comply with provincial and federal privacy legislations.

All study records, including audio recordings, transcripts, interview notes, screening questions, and contact information, will be labelled with a coded ID number, which will be assigned to you upon enrolment into the study. All electronic files (audio recordings, typed notes) will be saved in a secure password-protected computer drive at the University of Manitoba. Only the study staff will have access to the study records.

All paper records will be kept in a locked office and filing cabinet located in the Department of Biochemistry and Medical Genetics. Paper materials will be destroyed, and electronic materials will be permanently deleted from the University of Manitoba hard drive, 7 years following the completion of the study in Fall 2024.

Some people or groups may need to check the study records to make sure all the information is correct. All of these people have a professional responsibility to protect your privacy. These people or groups are:

- The Health Research Ethics Board of the University of Manitoba, which is responsible for the protection of people in research and has reviewed this study for ethical acceptability
- Quality assurance staff of the University of Manitoba who ensure the study is being conducted properly

VOLUNTARY PARTICIPATION AND WITHDRAWAL

Your decision to participate in this study is voluntary. You may refuse to participate or withdraw from the study at any time. If you withdraw from the study, all data you provided will be destroyed.

QUESTIONS

If you have any questions or concerns about the study, you may contact the student investigator, Daena Hirjikaka at hirjikad@myumanitoba.ca (phone number). You may also contact the

student's supervisor, Claudia Carriles Landry at claudia.carrileslandry@umanitoba.ca (phone number).

If you have questions about your rights as a research participant, you may contact the University of Manitoba Bannatyne Research Ethics Board by phone at 204 789-3255 or by email at bannatynereb@umanitoba.ca. Please feel free to print a copy of this consent page to keep for your records.

CONSENT SIGNATURES

1. I have read all pages of the consent form.
2. I have had a chance to ask questions and have received satisfactory answers to all of my questions.
3. I understand that by giving my consent I have not waived any of my legal rights as a participant in this study.
4. I understand that my records, which may include identifying information, may be reviewed by the research staff working with the Principal Investigator and the agencies and organizations listed in the Confidentiality section of this document.
5. I understand that I may withdraw from the study at any time and my data may be withdrawn prior to publication.
6. I understand I will be provided with a copy of the consent form for my records.
7. I am providing verbal consent to the researcher to sign on my behalf.
8. I agree to participate in the study.

I consent to audio and/or audio video recording of this interview (please check box): ☐

Name: _____ Date _____

(day/month/year)

Participant email address: _____

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has knowingly given their verbal consent

Name: _____ Date _____

(day/month/year)

Signature: _____ Role in the study:_____

Appendix D: Final codebook

Code	Subcode	Description
Benefits of Using SGT		
	Managing wait times through mainstreaming or faster turn around times	Mainstreaming of SGT means that patients do not have to go through the long wait times to see genetics for pre-test counselling prior to receiving the genetic test. This can reduce the amount of time it takes before a patient receives results from genetic testing.
	Overcoming barriers to improve access to genetic testing	The ability to use a SGT in clinical situations where a genetic test may be warranted but is not accessible through the public healthcare system, either due to strict eligibility criteria for receiving the test or due to restrictions on non-genetics HCPs being able to order the test.
	Research and Development leading to greater understanding of genetic conditions	Having access to more genotype and phenotype data through sponsored avenues enriches the understanding and knowledge of genetic diseases. New genetic tests may be developed and improved through lessons learned from sponsored programs.
Clinical Utility		The importance/value of a genetic test (sponsored) for the patient's/family's medical care/management.
Considerations for non-genetics HCPs ordering SGT		
	Implications of Genetic Testing	Ensure that the HCP ordering the SGT knows what the implications of genetic testing are, e.g. emotional distress, familial implications, Incidental findings.

	Interpretation of Results	Ensuring patient understands results from genetic testing e.g. Positive, Negative, VUS.
	Pre-and Post-test management of patients	Pre-test management involves managing patient expectations with the utility of the test, chances of getting a result and what those results may be. Post-test management involves recommendations for screening and cascade testing.
Data Sharing, Privacy, Security		The SGT program's use of patient data.
Consent		Perspectives on the consent form and whether it had adequate information for the patient to make an informed decision, along with risks of genetic testing e.g. data sharing, privacy, GNA, sending the sample across the border, third-party companies funding the tests etc.
Transparency/Clarity		Transparency from the program to the providers ordering the tests in terms of what will be done with the data, security and privacy measures, how the program works, how the NGS sequencing is being done, are there limitations to the test (e.g. no repeat expansion testing) what therapies are available by the sponsor etc.
Genetics Education during Medical Training/Genetics Education for non-genetics providers		The need for non-genetics specialists to receive more thorough training in medical school/residency/in their practice on genetics.
Genetics Exceptionalism		The idea that the practice of genetics is different than other specialties and is special in some way. Can be associated with gatekeeping of the practice
Implementation of SGT Programs		How could/ should SGT be implemented as a common

		model of testing within the provincial healthcare system in the participant's clinic and what do genetics professionals consider when deciding whether it should be integrated into their clinics/labs.
Institutional Policies on SGT or clinic model of using SGT		Whether or not individual institutions have policies on when to use SGT and what those policies/models are.
Lack of Homogeneity between SGT programs (all programs are different)		All SGT programs are different, some are more reliable and reputable than others, whereas some have more questionable practices. They cannot all be clumped together or perceived the same.
Post-Sponsored Test		How and whether clinics continue to offer a genetic test for an indication for which they were primarily using a sponsored test after that test has been discontinued.
Reliability/Validity of Reports		Reliability and validity of the lab offering the sponsored test (CLIA/CCMG approved), whether reports are well-written and provide all necessary information. Transparency in how and by whom the reports are being written and how the data is being analyzed etc.
Resources		
	Clinical Resources	The amount of people (workforce) in genetics clinics.
	Cost Considerations within the healthcare system	The finances allocated to provincial genetics clinics/labs to order genetic testing.
	Justification for Provincial funding	Using SGT to justify provincial funding of a genetic test if the SGT is discontinued by showing clinical utility and benefit for patient care, management and treatment.

	Laboratory Resources	The amount of workforce allocated to a genetic testing laboratory within the provincial healthcare system.
Sponsor's Motivation for Offering SGT Programs		Reasons behind why the pharmaceutical companies are sponsoring these tests and whether the decisions made e.g. data sharing, large panel curation etc. are in the best interest/benefit of the patient.
When are CGHPs using SGT in their practice		Situations in which providers are more likely to or do order SGT.