Exploring the integration of expanded carrier screening within Canadian fertility clinics

by

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ABSTRACT

Traditionally, carrier screening targeted individuals with family histories of genetic conditions or from specific ethnic backgrounds. However, this method is increasingly considered inadequate for accurate risk assessments. Expanded Carrier Screening (ECS) is a genetic test designed to screen for hundreds of autosomal recessive and X-linked inherited disorders to provide families with valuable information for reproductive decision-making. As guidelines across the world are being updated to incorporate recommendations for ECS provision, Canada has yet to establish such guidelines to aid providers in navigating ECS delivery. Previous studies have found that Fertility Healthcare Providers (FHP) are proponents of ECS and have the most opportunity to integrate this test into their practice, as they follow primarily a preconception cohort. Therefore, this study was designed to apply qualitative interviews to explore the experiences, perspectives and practices of Canadian FHP regarding ECS. This study interviewed six physicians and five genetic counsellors working in a fertility clinic across Canada on ECS and revealed four significant categories using a qualitative descriptive approach.

Inconsistencies were observed in the provision of ECS across fertility clinics, although more standardized practices were noted among patients using donor gametes. Participants identified significant challenges and barriers to implementing ECS, including limited genetic counselling access, competing clinic priorities, absence of Canadian ECS recommendations, and added financial burdens for patients and clinics. While most participants supported using ECS in their clinics, varying opinions arose concerning its clinical utility and value. The culture within the realm of FHP was found to be moulded by their patient population, professional experiences, and educational backgrounds, all influencing FHP perceptions of ECS and its integration into practice. Participants suggested several recommendations and changes to address the discussed barriers and challenges, such as novel approaches to ECS pre-test counselling, enhancing access to genetic counselling, and genetic counsellors requiring physician support for implementing ECS improvements. In summary, this study illuminated the diverse landscape of practices and policies regarding ECS within fertility clinics, highlighting the intricate complexities surrounding ECS implementation in private fertility settings.

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TABLE OF CONTENTS

ABSTRACT 2
ACKNOWLEDGEMENTS 3
TABLE OF CONTENTS 4
LIST OF ABBREVIATIONS 6
CHAPTER 1. LITERATURE REVIEW 7
1.1 Carrier Screening Overview 7
1.1.1 Carrier Screening Criteria 7
1.1.2 History of Carrier Screening 9
1.1.3 An Initial Ethnicity Focused Approach 9
1.2 Expanded Carrier Screening 11
1.2.1 Expanding to a Pan-Ethnic Approach 12
1.2.2 Criticisms of Ethnicity-Based Carrier Screening 12
1.3 Current Status of Carrier Screening in Canada 14
1.3.1 Canadian Carrier Screening Guidelines 14
1.3.2 ECS in Canada 15
1.3.3 Carrier Screening in Other Countries 15
1.4. Clinical Utility of ECS 19
1.4.1 Benefits of ECS 20
1.4.2 Limitations of ECS 22
1.5 Overview of Fertility Practice in Canada 24
1.5.1 Types of Fertility Treatment 24
1.5.2 Third-Party Reproduction 25
1.5.3 Professional Roles in Fertility 26
CHAPTER 2: INTRODUCTION AND RATIONALE 28
2.1 Introduction 28
2.2 Research Questions and Aims 28
CHAPTER 3. METHODS 30
3.1 Study Design 30
3.2 Theoretical Foundations 31
3.3 Recruitment and Eligibility 31
3.4 Qualitative Data Analysis 34
3.5 Positionality Statement 38
CHAPTER 4. RESULTS 40
4.1 Screening Questionnaire Results 40
4.2 Qualitative Findings 41
4.2.1 Category One: Clinic Practices and Policies 43
4.2.2 Category Two: Barriers and Challenges 50
4.2.3 Category Three: Fertility Provider Culture Shapes ECS Practices 58
4.2.4 Category Four: Participant-Driven Changes and Recommendations: Enhancing ECS Delivery 69
CHAPTER 5. Discussion 80
5.1 Providers' Personal and Professional Views, Values, and Education Guide ECS Practices 80
5.1.1 Uncommon Does Not Equal Insignificant 82

5.1.2 Training Differences between Genetic Counsellors and REI Physicians May Influence Values 84
5.2 Influence of Liability Concerns 85
5.3 Fertility Patients Influence FHP Practice 87
5.4 Barriers 89
5.4.1 Is ECS Beyond the Scope of REI Physicians? A Call for Increased Genetics Education 89
5.4.2 Canada Has a Major Shortage of Genetics Providers 90
5.4.3 ECS is Not a Priority 91
5.4.4 Lack of Professional Guidance 92
5.4.5 Perceptions and Considerations of Costs 93
5.5 Changes and Recommendations: Enhancing ECS Delivery 94
5.5.1 ECS Should be Offered Pre-Conceptionally 94
5.5.2 Novel Approaches to Pre-test Counselling and Support from ECS Laboratories 95
5.5.3 The Public Health System Should Offer ECS 97
5.5.4 Collaboration between Genetic Counsellors and REI Professionals in Fertility 98
LIMITATIONS 99
FUTURE DIRECTIONS 100
REFERENCES 102
APPENDIX 112
APPENDIX A: Recruitment Materials 112
Recruitment Email Invitation 112
APPENDIX B: Online Screening Questionnaire 112
APPENDIX C: Consent Forms 114
Online Consent Disclosure Statement 114
Interview Consent Form 115
APPENDIX D: Interview Guide 119

LIST OF ABBREVIATIONS

ACMG: American College of Medical Genetics and Genomics
ACOG: American College of Obstetricians and Gynecologists
AJ: Ashkenazi Jewish
ART: Assisted Reproductive Technology
CAGC: Canadian Association of Genetic Counsellors
CARTR: Canadian Assisted Reproductive Technologies Register Plus registry
CCMG: Canadian College of Medical Geneticists
CF: Cystic Fibrosis
CFAS: Canadian Fertility and Andrology Society
ECS: Expanded Carrier Screening
IUI: Intrauterine Insemination
IVF: In Vitro Fertilization
GC: Genetic Counsellor
GCA: Genetic Counselling Assistant
GP: General Practitioner
MD: Medical Doctor
NBS: Newborn Screening
NGS: Next-Generation Sequencing
NIPT: Non-Invasive Prenatal Test
NSGC: National Society of Genetic Counsellors
OBGYNs: Obstetricians and Gynecologists
PI: Primary investigator
PGT: Preimplantation Genetic Testing
PGT-A: Preimplantation Genetic Testing for Aneuploidy
PGT-M: Preimplantation Genetic Testing for Monogenic Disorders
PGT-SR: Preimplantation Genetic Testing for Structural Rearrangements
PSS: Professional Status Survey
RANZCOG: Royal Australian and New Zealand College of Obstetricians and Gynaecologists
REI: Reproductive Endocrinology and Infertility
SCD: Sickle Cell Disease
SMA: Spinal Muscular Atrophy
SOGC: Society of Obstetricians and Gynaecologists of Canada

CHAPTER 1. LITERATURE REVIEW

1.1 Carrier Screening Overview

Carrier screening is a genetic test that assesses an individual's risk of being a carrier for a specific genetic disorder (Delatycki et al., 2020; Holtkamp et al., 2017; Ramdaney et al., 2022). Generally, individuals who are carriers are healthy, do not exhibit symptoms of the disease and are not at risk of developing it, but they have an increased risk for an inherited disorder in their offspring (Holtkamp et al., 2017; Rose & Wick, 2016; Delatycki et al., 2020). The primary goal of reproductive carrier screening is to identify carriers of genetic conditions, especially autosomal recessive ones. In autosomal recessive disorders, two copies of an abnormal gene (also referred to as a mutation or pathogenic variant in a gene) must be present for a disorder to be expressed in an individual. If both parents are carriers of an autosomal recessive disorder, there is a 25% chance with each pregnancy that their child will inherit two copies of the abnormal gene and be affected by the disorder (Rose & Wick, 2016). Some of the more well-known autosomal recessive conditions for which carrier screening is conducted include cystic fibrosis (CF), sickle cell anemia, Tay Sachs disease, and spinal muscular atrophy (SMA) (Gregg et al., 2021). Females can also be carriers of X-linked conditions due to pathogenic variants on the X chromosome. While males with one X chromosome will develop an X-linked condition if they inherit a pathogenic variant, female carriers typically show no symptoms (Basta & Pandya, 2023; Gregg et al., 2021). Female carriers of X-linked conditions have a 50% risk of having an affected son and a 50% chance of having a carrier daughter (Basta & Pandya, 2023). Examples of X-linked conditions for carrier screening include Fragile X syndrome, Duchenne/Becker muscular dystrophy, and hemophilia (Wilson et al., 2016). Carrier screening tests can be designed to target a broad range of conditions or focus on particular disorders based on the individual's ethnicity, family history, or personal preferences (Lazarin et al., 2016). Various approaches, such as molecular analysis, enzymatic and biochemical testing are employed to identify carriers of genetic conditions (Wilson et al., 2016).

1.1.1 Carrier Screening Criteria

The principal objective of screening is to detect potential health risks in apparently healthy individuals within a population. Screening test results do not provide a definitive diagnosis but offer a probability of an individual having a particular condition (World Health

Organization, 2020). Wilson and Jungner established ten guiding principles for selecting suitable conditions for screening and are regarded as the benchmark for screening programs (Wilson & Jungner, 1968). These criteria were initially designed to identify those susceptible to developing a disease but have been applied to carrier screening programs focusing on identifying individuals with an increased reproductive risk of having a child with a disease.

The commonly acknowledged criteria for carrier screening protocols, as outlined by Wilson et al. (2016), encompass the following factors:

1. Autosomal recessive or X-linked disorders that are anticipated to have a substantial clinical impact and cause significant morbidity throughout an individual's lifetime.
    - The presence of available interventions capable of influencing the clinical outcome
    - A high prevalence of expected carriers within the population
2. The availability of cost-effective and dependable testing, characterized by a high positive predictive value and detection rate, coupled with a low false positive rate.
3. Adequate patient access to genetic counselling services and facilitating an informed consent process.
4. Participation in carrier screening should be voluntary, driven by the patient's request or choice.

In most cases, carrier screening is offered before or during pregnancy, allowing individuals or couples to understand their reproductive risk for autosomal recessive or X-linked genetic conditions in their offspring (Gregg et al., 2021). Pre-conception carrier screening can help individuals make informed decisions about family planning and choosing personalized reproductive options and interventions in response to an increased risk of having children affected by a specific genetic condition (Delatycki et al., 2020). By knowing their carrier status, individuals or couples could consult with genetic counsellors or other healthcare providers to discuss the potential risks, explore options for reproductive planning, or consider assisted reproductive technologies like in vitro fertilization (IVF) with pre-implantation genetic testing (PGT) (Holtkamp et al., 2017). Performing carrier screening during pregnancy provides patients with their carrier status information, empowering them to consider various pregnancy management choices, such as early prenatal diagnosis with chorionic villus sampling or

amniocentesis, pregnancy termination, or preparation for the birth of an affected offspring (Cannon et al., 2019).

1.1.2 History of Carrier Screening

The history of carrier screening can be traced back several decades, and its evolution is closely aligned with key advances in the genetics and molecular biology field and the understanding of inherited genetic disorders (Holtkamp et al., 2017; Rose & Wick, 2016). Historically, carrier screening tested for a single or small subset of diseases in specific populations with a known high incidence of certain genetic conditions associated with severe morbidity or mortality (Gregg et al., 2021; Holtkamp et al., 2017; Lazarin & Haque, 2016). Over time, two methods are generally utilized in reproductive genetic carrier screening: targeted analysis, also referred to as genotyping, and full sequencing. Due to cost and technical limitations, initial carrier screening programs used targeted analysis, often targeting common variants in specific ethnic groups or populations (Azimi et al., 2016). This first approach identifies the most well-defined genetic variants linked to particular disorders using a genotype-based panel but does not provide a comprehensive analysis of the entire gene (Azimi et al., 2016).

1.1.3 An Initial Ethnicity Focused Approach

In 1970, the first carrier screening program was created and implemented for Tay Sachs disease for individuals with Ashkenazi Jewish (AJ) heritage using a biochemical test measuring Hexosaminidase A activity (Rose & Wick, 2016). Tay Sachs disease is an autosomal recessive life-limiting neurologic, genetic condition with a high prevalence in the AJ population, with 1/25 individuals being carriers, whereas about 1/300 individuals in the general population are carriers (Gregg et al., 2021; Rose & Wick, 2016). Implementing biochemical screening among the AJ population was a crucial milestone and laid the foundations for launching carrier screening programs for different genetic conditions in other populations (Gregg et al., 2021).

In pursuit of Tay-Sachs screening, carrier screening programs for cystic fibrosis followed during the early 1990s as a result of the discovery of the CFTR gene responsible for cystic fibrosis, which led to the development of a CF carrier screening program (Ioannou et al., 2014). Throughout the 1990s, screening programs for CF emerged across the globe, which largely targeted White individuals of European ancestry, where CF is more prevalent (Grody et al.,

2001). The National Institute of Health (NIHc was the first to publish a consensus statement about carrier screening in 1997, recommending that individuals with a "family history of CF, partners of individuals with CF, couples planning a pregnancy, and couples undergoing prenatal testing should be offered CF screening" (Rose & Wick, 2016). Following the NIH in 2001, the ACOG published guidelines recommending CF carrier screening to all individuals considering a pregnancy or who are currently pregnant and are of Northern European or Eastern European descent (ACOG Committee Opinion No. 486, 2011).

Sickle cell disease (SCD) screening marks a key milestone in carrier screening history as the ability to detect SCD carriers originated via the newborn screening program (NBS) for the condition in the 1970s in the US, followed by Canada in 1988. NBS is a public health program designed to identify a subset of genetic disorders in newborn infants shortly after birth. Its primary aim is to catch these conditions early, before they can lead to significant health issues, enabling timely treatment and intervention (Groulx-Boivin et al., 2023).

SCD newborn screening was initiated due to its high carrier frequency (1/13 carrier frequency in the African-American population, 1/20 in the Hispanic population, and 1/66 in the general population) and the ability to scale hemoglobin electrophoresis to a population level (Naik & Haywood, 2015). NBS is intended to benefit infants born with a treatable, rare disease from early diagnosis and pre-symptomatic treatment. Likewise, carrier screening provides parents with knowledge about their carrier status beforehand, which can also aid in facilitating a timely diagnosis of affected infants post-birth or with prenatal testing (Johansen Taber et al., 2019; Pasquier et al., 2023). Thus, carrier screening and NBS can grant the newborn access to treatment at an earlier stage and can spare families from a prolonged diagnostic process, which can be emotionally and physically taxing (Johansen Taber et al., 2019). While it can be argued that carrier screening may seem less necessary due to the comprehensive coverage of prevalent genetic conditions by NBS, the aims of these two screening programs are distinctive. Overall, carrier screening offers a proactive approach that promotes informed reproductive decision-making, and includes conditions with no treatment, whereas NBS allows for early detection and treatment to help minimize the impact of these conditions on a child's health (de Wert et al., 2021).

Unfortunately, the initial SCD NBS programs were established without adequate education and counselling available to families, leading to infants who were carriers for sickle cell (sickle cell trait) being falsely considered to have sickle cell disease (Miller et al., 2010; Naik & Haywood, 2015; Pecker & Naik, 2018). For context, individuals who carry only one copy of the "sickle" variant are not symptomatic for SCD and are referred to as “sickle cell trait" or being a carrier for SCD (Miller et al., 2010; Pecker & Naik, 2018). In addition, as many organizations and employers implemented voluntary screening programs, this led to stigmatization and discrimination in various aspects of the lives of individuals with sickle cell trait (Bonham et al., 2010; Naik & Haywood, 2015). Among the affected communities, mainly Black individuals, there was a sense of coercion surrounding testing, resulting in employment, health insurance, and marriage discrimination (Naik & Haywood, 2015). Despite its initial intentions, universal screening for SCD created more harm than good and brought to attention critical factors to reflect on when considering the broad implementation of a carrier screening program.

1.2 Expanded Carrier Screening

Two methods utilized in reproductive carrier screening are targeted analysis, also referred to as genotyping, and full gene sequencing. Traditional carrier screening used targeted analysis, which involves analysis of common disease-causing variants in the gene of interest. Targeted analysis was generally selected in traditional carrier screening because of reduced cost and effective interpretation, but is limited since it does not provide a comprehensive analysis of the entire gene and novel disease causing variants would be missed (Azimi et al., 2016).

The previously described targeted approach defined in traditional carrier screening guidelines (Wilson et al., 2016) was challenged when Expanded Carrier Screening (ECS) first entered the genetics scene in 2009. Rapid advances in genetic technology and innovations in next-generation sequencing (NGS) made it possible to look at hundreds of genes in one test at a reasonable cost, rather than applying a targeted or ethnicity-based screening approach (Lazarin & Haque, 2016; Rothwell et al., 2017). With NGS, the full gene can be analyzed, providing a wider coverage in the ability to evaluate genes and mutations for many genetic conditions. NGS results have higher carrier detection rates as it allows the inclusion of many more mutations per disease

than is possible with traditional genotyping-based panels (Azimi et al., 2016). Further, NGS studies can be performed at approximately the same cost as was previously required using targeted analysis (Abulí et al., 2016; Azimi et al., 2016). The transition from a targeted variant-based approach to a gene-based approach has reduced the need to target screening to specific populations.

1.2.1 Expanding to a Pan-Ethnic Approach

Since 2011, the United States has offered carrier screening universally for cystic fibrosis and SMA to all pregnant women and couples planning a pregnancy (ACOG Committee Opinion No. 486, 2011; Prior, 2008). Following the introduction of pan-ethnic screening for CF and SMA, a discussion of extending pan-ethnic screening for other genetic diseases arose to provide "equitable access to reproductive information." Relying on patients' self-identified ethnicity to assess risk was becoming increasingly challenging, and there was an increasing frequency of genetic diseases in populations not offered targeted screening (Lazarin & Haque, 2016; Ross, 2012).

1.2.2 Criticisms of Ethnicity-Based Carrier Screening

There is increasing support that using patient self-reported ethnicity or ancestry is suboptimal to assess genetic risk and comes with inherit flaws. For instance, the terms 'race,' 'ethnicity,' and 'ancestry' are all used in determining eligibility for screening programs, as these terms are often used interchangeably. While these terms do have some overlap, they have different meanings and can make it more complex when considering the prevalence of various genetic conditions for diverse populations (Hinton et al., 2011). Race is a social construct that categorizes people based on physical characteristics and is typically associated with broad groups such as Black, White, Asian, Indigenous, and others. Ethnicity is based on cultural and social associations, rather than physical traits, that a person self-identifies with and shares common characteristics such as nationality, geographic origin, religion, or language. In contrast, ancestry is a person's biological and genetic connection to their assumed continental ancestors. It can be traced through genealogical research, such as looking at common genetic markers associated with a specific place of origin (Hinton et al., 2011).

The issue with using ethnicity to determine carrier screening eligibility is that it may not always be the most accurate or reliable method for determining genetic risk. This is not to argue

that ethnicity does not play a part in carrier screening, particularly when considering residual risk as part of decision-making. However, ethnicity should be regarded as only part of the picture. First, ethnicity-based carrier screening requires patients to accurately know and report their ancestral origins, which many people fail to do so accurately for a variety of reasons, such as being of mixed heritage, being unaware of non-paternity, and terms such as race and ethnicity being used interchangeably (Hinton et al., 2011). One study reviewed responses to questions about self-identified race and ethnicity and found people tend to either identify with multiple racial identities or towards the 'Americanized' version of their identity, indicating they are less likely to view themselves in terms of continental ancestry as time goes on (Perez & Hirschman, 2009). A study by (Kaseniit et al., 2020) found "9% of individuals had >50% genetic ancestry from a lineage inconsistent with self-reported ethnicity" proving that self-reported ethnicity was an insufficient method of assigning genetic ancestry.

Numerous other examples have shed light on the shortcomings of ethnicity-based screening. For instance, in the case of beta-hemoglobinopathy diagnoses from newborn screening, 12% of cases were identified in infants who did not belong to the targeted ethnic groups specified in ACOG's guidelines at the time (Lazarin & Haque, 2016). Furthermore, as screening programs specifically targeting Tay Sachs disease within the AJ population gained traction, the prevalence of this disease increased three to fourfold in non-Jewish infants compared to their Jewish counterparts (Ross, 2012). In another study, Lazarin et al. (2013) conducted a comparison between ethnicity-based screening and an expanded panel of 417 disease-causing mutations linked to 108 recessive diseases. The study's results unveiled 433 individuals identified as carriers who would have gone undetected through conventional ethnicity-based screening. Intriguingly, this group contained 26.3% of familial dysautonomia carriers who did not report any Jewish ancestry, despite the fact that, traditionally, carrier screening for this disease was exclusively available to individuals with Jewish heritage (Lazarin et al., 2013).

Newborn screening has moved away from using ancestry to determine eligibility for screening due to the belief that all infants deserve equitable access (Ross, 2012). A similar approach is called for in the carrier screening setting, as practices that offer selective screening

based on ethnicity fail to acknowledge the diversity in our society and generalize the multifaceted associations between ancestry and genetic risk (Hinton et al., 2011; Ross, 2012).

1.3 Current Status of Carrier Screening in Canada

Carrier screening and the extent and types of conditions tested for may vary based on factors such as public health guidelines, personal preferences, and available testing options (Lazarin et al., 2016; Ramdaney et al., 2022). Professional societies and organizations in genetics and reproductive medicine have issued several practice guidelines over the years, providing healthcare providers with recommendations on carrier screening. This section will review the most recent Canadian carrier screening recommendations and how they compare to other countries.

1.3.1 Canadian Carrier Screening Guidelines

The Society of Obstetricians and Gynaecologists of Canada (SOGC) Genetic Committee, along with the Canadian College of Medical Geneticists (CCMG) Clinical Practice Committee, jointly issued carrier screening recommendations in 2002, 2006, 2008, and 2016, all of which are currently retired (Wilson et al., 2016). These guidelines suggest offering reproductive carrier screening to individuals with a family history of genetic conditions or specific ethnic backgrounds. The recommendation is for physicians to discuss reproductive carrier screening with all women and families and inquire about a patient's family history of certain genetic conditions. Should concerns be identified, providers should refer patients promptly to a genetics provider and genetic counselling should be provided to those at risk of passing on inherited conditions (Wilson et al., 2016).

Following these generalized recommendations, there is also a dedicated section covering AJ screening, as well as recommendations for other ethnic groups deemed a higher risk due to founder effects, such as having Cree ancestry, Amish/Mennonite/Hutterite groups, and some founder populations from Quebec, New Brunswick, and Newfoundland. The SOGC-CCMG provides more detailed guidance for five common syndromes: Fragile X, X-linked Hemophilia, Hemoglobinopathies/Thalassemia, SMA and CF. While the SOGC-CCMG does not recommend universal carrier screening for any genetic conditions, including Fragile X, SMA, and CF, they provide criteria to help providers recognize whom they should offer carrier screening to.

Typically, this target is based on certain family history criteria or being of a specific ethnic background. Some conditions have more features to help guide providers in whom to offer carrier screening to, such as Fragile X, which has distinct flags in the family history, and hemoglobinopathies, which has findings that can be seen through hemoglobin analysis. However, this is not the case for autosomal recessive conditions, like SMA and CF where screening is only recommended if there is an increased risk due to personal or family history (Wilson et al., 2016).

1.3.2 ECS in Canada

Currently, there are three circumstances in Canada where individuals can discover their carrier status for inherited monogenic disorders (Adapted from Wilson et al. 2016):

1) The targeted recommended preconception or prenatal carrier screening process described in section 1.6.1 by the SOGC-CCMG
2) Diagnosis of an affected child, including postnatal provincial newborn metabolic screening programs or
3) Direct-to-consumer (DTC) or private-pay physician-ordered ECS

In Canada, ECS is a private pay genetic test that screens hundreds of autosomal recessive and X-linked disorders, which are not tailored to a patient's ancestry (de Wert et al., 2021; Lazarin & Haque, 2016). The 2016 recommendations from the SOGC-CCMG briefly broach the topic of ECS and summarize current research and opinion statements centring ECS, but they do not provide any recommendations on the integration of ECS into practice. This section emphasizes that "family health history-based risk assessment remains the gold standard in the initial evaluation of heritable conditions" (Wilson et al., 2016). The SOGC-CCMG's discussion of ECS is notably limited and outdated. Overall, this approach offers minimal guidance to Canadian healthcare providers in the context of providing ECS in today's landscape.

1.3.3 Carrier Screening in Other Countries

Professional organizations worldwide have undergone updates in their guidelines and recommendations, with many now advocating for the provision and discussion of carrier screening for all individuals planning a pregnancy or currently expecting. In contrast to Canada, recommendations from other nations propose the phasing out of ethnicity-based screening. To gain insight into Canada's approach, a comparative analysis with Australia (which shares a

government-funded healthcare system like Canada) and the United States (where healthcare is not publicly funded) is detailed in Table 1. European countries have also witnessed significant developments in ECS initiatives. However, due to the limitations of this review, an in-depth examination of the European context is beyond the scope of this study. Nevertheless, it is worth mentioning that several European fertility clinics routinely offer preconception ECS, and European FHP have expressed a pressing need for further ethical guidance in the context of ECS (de Wert et al., 2021).

Table 1. Comparison of carrier screening recommendations: Canada, the United States, and Australia

	Canada[1]	USA[2]	Australia[3]
Cystic Fibrosis	Not universally offered ▪ Recommended and covered if there is family or medical history of CF	Universally offered	Universally offered and covered by Medicare starting November 2023
Spinal Muscular Atrophy	Not universally offered ▪ Recommended and covered if there is family history of SMA	Universally offered	Universally offered and covered by Medicare starting November 2023
Hemoglobin-opathies	Not universally offered ▪ Recommended and covered for certain ethnic background	Universally offered	Universally offered
Fragile X Syndrome	Not universally offered ▪ Recommended and covered if there is a family or medical history of intellectual disability, autism, or primary ovarian insufficiency	Universally offered	Universally offered and covered by Medicare starting November 2023
Expanded Carrier Screening	Briefly addressed in 2016 by the SOGC-CCMG. Consider ethnicity-based screening as the "gold standard" in comparison to ECS.	▪ ACMG first addressed ECS in 2015 addressing pre- and post-test counselling recommendations. ▪ The phrase "expanded carrier screening" be replaced by "carrier screening" ▪ Adopting a more precise tiered system based on carrier frequency	▪ Acknowledges ethnicity is poorly predictive of carrier frequency in Australia. ▪ Providers can offer covered 3-panel option (FXS, CF, SMA) or expanded panel

1. Adapted from "Joint SOGC–CCMG Opinion for Reproductive Genetic Carrier Screening: An Update for All Canadian Providers of Maternity and Reproductive Healthcare in the Era of Direct-to-Consumer Testing" by Wilson et al., 2016, *Journal of Obstetrics and Gynecology Canada*, *38*(8), 742-762.e3. https://doi.org/10.1016/j.jogc.2016.06.008
2. Adapted from "Screening for autosomal recessive and X-linked conditions during pregnancy and preconception: A practice resource of the American College of Medical Genetics and Genomics (ACMG)" by Gregg et al., 2021, *Genetics in Medicine*, *23*(10), 1793–1806. https://doi.org/10.1038/s41436-021-01203-z
3. Adapted from "Australia—Genetic carrier screening" by The Royal Australian and New Zealand College of Obstetricians and Gynecologists (RANZCOG), 2019, available from https://ranzcog.edu.au/wp-content/uploads/2022/05/Genetic-carrier-screeningC-Obs-63New-March-2019_1.pdf

The United States

The American College of Medical Genetics and Genomics (ACMG) first addressed ECS in a 2015 statement which centred around the informed consent process and pre- and post-test counselling recommendations (J. G. Edwards et al., 2015). Additionally, the ACMG has embraced an "ethnic and population neutral approach" which commences with carrier screening for CF in 2001 and in 2008 for SMA (Grody et al., 2001; Prior, 2008). In 2021, the ACMG developed a new clinical practice resource, recommending carrier screening being "ethnic and population neutral and more inclusive of diverse populations to promote equity and inclusion" (Gregg et al., 2021). This clinical practice resource recommends a four-tiered approach to offer screening for individuals in the process of planning a pregnancy or currently expecting (Gregg et al., 2021). Tier one is similar to traditional carrier screening approaches and includes CF, SMA, and risk-based screening based on personal and family history. Tier two includes autosomal recessive conditions with a carrier frequency of a least 1/100 and tier three contains conditions with a carrier frequency of 1/200 and X-linked conditions. Lastly, tier four includes the conditions in all other tiers in addition to some rarer conditions, and is only indicated for certain circumstances, such as consanguinity or if the family/medical history warrants it.

To ensure equitable screening for all racial and ethnic groups, the ACMG recommends tier three screening be offered to all pregnant patients and those planning a pregnancy, which includes 113 genes in lieu of tiers one or two (Gregg et al., 2021). Lastly, the ACMG highlights that ECS is an acceptable strategy for carrier screening and that ECS panels should be carefully crafted to include inherited autosomal recessive and X-linked conditions that are most relevant to the health of the population as a whole.

Australia

Currently, the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) recommends information on carrier screening be offered to individuals in the process of planning a pregnancy or currently expecting, with the option of a three-gene panel to test for the most frequent three conditions (CF, SMA and Fragile X) (RANZCOG, 2019). In Australia, carrier screening is predominantly offered on a private pay basis. The cost ranges from approximately $350 AUD for a three-panel screen, with expanded genetic carrier screening priced between $579 AUD and $900 AUD. The Australian Federal

Government's Department of Health recently announced a plan for government-funded (Medicare) carrier screening for the three gene panel to be implemented by November 2023 (Archibald et al., 2022).

From 2018-2021, the Australian Reproductive Genetic Carrier Screening Project, also known as *Mackenzie's Mission*, applied $20 million in funding from the Australian Government to investigate "the acceptability and feasibility" of a readily accessible funded carrier screening program (Archibald et al., 2022). In pursuit of this goal, the research trial recruited 9,107 Australian couples and screened them for over 750 serious childhood-onset genetic conditions (Archibald et al., 2022). The findings of Mackenzie's Mission revealed that approximately 1 in 50 couples were identified as having an increased likelihood of having a child affected by one of the 750 screened conditions (Mackenzie's Mission, 2022). Notably, through surveys administered at different stages of the study, participating couples indicated the information obtained from this screening was highly valued. Almost all participants expressed the belief that such screening should be made available to all future parents in the general community (Archibald et al., 2022).

1.4. Clinical Utility of ECS

Many studies have shown the benefits and limitations of pan-ethnic ECS compared to traditional ancestry-based screening. It is estimated 2–4% of couples are at risk of conceiving a child with an autosomal recessive or X-linked genetic disorder (Capalbo et al., 2021). Past literature suggests the effectiveness of ECS should be evaluated based on the capacity to advance autonomous reproductive choice (Kraft et al., 2018; Van Der Hout et al., 2017). Individuals who have undergone ECS reported knowing their reproductive risks and being able to make autonomous decisions was important to them, with many indicating they felt more information is better (Kraft et al., 2018). Several studies have shown that ECS results influence reproductive decision-making, especially when done pre-conceptionally, with the most common decision for at-risk couples is pursuing IVF with PGT (Ghiossi et al., 2018; Kraft et al., 2018). Other studies have also shown that undergoing ECS provides individuals with additional personal benefits, such as feeling informed about their reproductive risks, being prepared for the birth of their child, as well as aiding in reducing the stigmatization around being a carrier (Van Der Hout et

al., 2017). In specific scenarios, carrier screening might also enhance the level of care for affected children by enabling early diagnosis and therapeutic interventions (Pasquier et al., 2023).

1.4.1 Benefits of ECS

ECS offers several benefits, contributing to its increasing popularity and implementation in various healthcare settings. Some key advantages of ECS outlined in further detail below include broader detection of genetic conditions, diverse population coverage, cost and time efficiency, public health impacts, and supporting informed reproductive decision-making.

1) Broader Detection of Genetic Conditions

ECS encompasses many genetic disorders, far more than traditional carrier screening methods. This broader coverage increases the chances of identifying carriers of various genetic conditions who may not have been detected through narrower testing approaches. ECS strives to extend the current roster of genetic disorders detected through traditional carrier screening. For instance, a study applying ECS to a multi-ethnic U.S. population of 23,453 individuals revealed that 69-77% of identified carriers would not have been detected if the screening guidelines issued by the ACMG or the ACOG were applied at the time of the study (Lazarin et al., 2013). This expansion is crucial, considering Mendelian diseases collectively contribute to approximately 20% of infant mortality and around 18% of pediatric hospitalizations (Kingsmore, 2012). Beyond infancy, statistics indicate that about one in three children affected by genetic conditions will not survive past the age of five, and many of them will experience significant health issues with potential long-term consequences (Schofield et al., 2023).

2) Diverse Population Coverage

ECS is designed to include individuals from diverse ethnic backgrounds and populations. Unlike traditional carrier screening that may be based on specific ethnic groups, ECS aims to identify carriers across different populations, addressing the limitations of ethnicity-specific testing. ECS operates independently of patients having accurate knowledge about their ancestry or family history. In addition to identifying carrier status in tested individuals, ECS can facilitate the identification of carriers among their family members through cascade testing. Relatives can

be offered genetic testing based on the initial positive result, further expanding the reach of genetic risk assessment (Capalbo et al., 2021).

3) Cost and Time Efficiency and Public Health Impact

On a larger scale, widespread ECS implementation could have a positive impact on public health by reducing the occurrence of genetic conditions and associated healthcare costs. By identifying carrier couples and enabling them to make informed reproductive choices, ECS can potentially reduce the incidence of certain genetic disorders in the population, thereby decreasing the burden of these conditions on families and healthcare systems. Given that population screening has demonstrated a reduced incidence of targeted diseases in the past (e.g., public screening for Down syndrome), it is reasonable to anticipate that the large-scale implementation of ECS would similarly impact a substantial portion of related mortality and morbidity (Lazarin & Haque, 2016). This can be particularly advantageous within a publicly funded healthcare system where it is crucial to weigh how ECS can positively affect resource allocation. For instance, Schofield et al. (2023) demonstrated that ECS is cost-saving compared to not offering population screening by averting affected births by one-third, which leads to the associated downstream health service savings. Further, they also found ECS to be more cost-effective than screening for the three main conditions (CF, SMA, Fragile X). Similarly, Beauchamp et al. (2019) showed that an ECS panel encompassing 176 conditions could provide cost-savings by avoiding affected cases and gaining life years, compared to minimal screening for CF and SMA.

4) Informed Reproductive Decisions

Identifying carrier status early on allows couples to make informed decisions about family planning. Couples facing potential risks have the choice to pursue prenatal diagnosis, engage in preimplantation genetic testing for monogenic conditions (PGT-M), explore gamete donation, consider adoption, or decide not to have children (Pasquier et al., 2023). One study analyzed the outcomes of ECS of 766 couples, which included an IVF and natural conception group. A total of 20 couples (2.6%) were identified as being at risk of conceiving a child with an autosomal recessive or X-linked genetic disorder (Capalbo et al., 2021). Of these, 15 out of 20 couples took proactive measures to mitigate their risk by enrolling in an IVF/PGT-M program (Capalbo et al., 2021).

1.4.2 Limitations of ECS

Numerous limitations associated with ECS have been documented, including complicated results, potential psychological impacts on individuals, and insufficient availability of supporting genetic healthcare professionals to provide counselling. Further, ECS panels encompass many genes beyond guideline recommendations, as well as there are concerns that the financial barriers could render the test inaccessible to many.

1) ***Complex and Uncertain Results***

ECS results can often be complex and not straightforward, such as identifying carrier status for exceedingly rare or poorly described conditions or for genetic variants where the test's sensitivity, specificity, and predictive value are only known in specific ethnic groups (Lazarin & Haque, 2016). ECS is a screen and will not identify all carriers, some will have a VUS that are not reported, some will have variants that are in regions not analyzed by the test and will lead to a false negative, in addition to other gene specific technical challenges (de Wert et al., 2021). Consequently, while ECS may identify carrier status, there may be limited insight into the genuine clinical risk for future offspring.

2) ***Psychological Impact***

Questions have been raised about the usefulness of the added information on carrier status ECS provides and justifying potential drawbacks like cost, follow-up testing, and increased risk of miscarriage associated with prenatal testing. Participants in one study found the testing process distressing and were surprised by positive results despite counselling about carrier prevalence (Henneman et al., 2016). Furthermore, there are concerns about carriers experiencing 'self-stigma,' associated with a diminished perception of their health (van der Hour et al., 2017). For instance, a study showed that informing individuals of their carrier status for CF had a negative impact on their self-perceived health (Axworthy et al., 1998). This emotional impact can intensify when ECS results are complex, potentially affecting other family members, or when carriers face health-related implications (Sagaser et al., 2023).

3) ***Limited Genetic Counseling Resources***

Effectively conveying necessary information about ECS in pre and post-test counselling demands significant time and expertise. However, the availability of genetic counsellors is

restricted. According to the 2022 Professional Status Survey (PSS) by the Canadian Association of Genetic Counsellors (CAGC), there are approximately 700 Canadian genetic counsellors, resulting in fewer than one genetic counsellor for every 6,000 individuals (Canadian Association of Genetic Counsellors, 2022). This situation likely burdens non-genetics practitioners who often lack specialized genetics training, including obstetricians, reproductive endocrinology and infertility (REI) specialists, and midwives, who might struggle to meet the demands of counselling patients on ECS (Benn et al., 2014; Cho et al., 2013).

4) ***Selection of Conditions for Screening Panels***

The process of determining which disorders to include in carrier screening guidelines and ECS panels presents its own challenges. In alignment with the screening criteria discussed in Section 1.1, the ACMG has suggested that universally screened diseases should exhibit a severe natural course, (Gregg et al., 2021). However, many ECS companies' panels encompass over 300 conditions, often extending beyond the ACMG's recommended list (Lazarin et al., 2014). Further, the inclusion of some rare disorder genes on these panels makes results interpretation and risk assessment complicated, since the information is often reliant on limited available data from small groups of affected individuals, where the knowledge about the range of genotypes and phenotypes association is minimal (Haque et al., 2016). No current guidelines specify which conditions should be included on an ECS panel. However, a broad agreement within professional organizations is that panels should prioritize childhood-onset conditions with the potential to affect the child's quality of life substantially (Henneman et al., 2016; Sparks, 2020).

5) ***Financial Barriers***

The cost of private pay ECS can influence its uptake, disproportionately affecting access for individuals with lower socio-economic status, underserved populations, and those in rural areas (Schofield et al., 2023). Out-of-pocket costs for ECS can range from $400 - $800 CAD (Invitae Corporation, 2023; LifeLabs Genetics, 2023.) Additionally, the feasibility of downstream fertility treatments, such as PGT-M or using donor gametes, among carrier couples should also be considered, as the ability to make such reproductive decisions following the results may be inaccessible and unaffordable for some (Lazarin & Haque, 2016).

1.5 Overview of Fertility Practice in Canada

Fertility clinics in Canada are specialized medical facilities that provide services to individuals and couples facing conception and reproductive health challenges. One in six Canadian couples is estimated to struggle with infertility (Armstrong, 2022). The demand for infertility treatment continues to grow as couples have children later in life and more single people and 2SLGBTQI+ families seek reproductive assistance (Armstrong, 2022; Boivin et al., 2007). Between 2013 and 2018, a total of 183,739 fertility treatment cycles were recorded by the Canadian Assisted Reproductive Technologies Register (CARTR) Plus registry, corresponding with 31,811 pregnancies that resulted in live births (Lanes et al., 2020).

The provincial health authorities regulate Fertility clinics in Canada and adhere to specific guidelines and regulations. The Canadian Fertility and Andrology Society (CFAS) is the main professional organization that provides guidance and standards for fertility clinics and professionals (Canadian Fertility and Andrology Society, 2023). CFAS is comprised of over 800 members representing the fields of medicine, basic sciences, embryology, andrology, nursing, genetics, ethics, law, imaging, counselling, and management (Canadian Fertility and Andrology Society, 2023). Fertility clinics are available across various provinces in Canada, with a concentration in major metropolitan areas like Toronto, Vancouver, Montreal, and Calgary. Across the four maritime provinces, there are just three fertility clinics, and only two offer IVF (Armstrong, 2022). Costs can vary widely depending on the type of treatment and clinic. Some provinces provide partial or complete coverage for fertility treatments under their provincial healthcare plans, while in others, individuals may need to pay for treatments out of pocket. Out-of-pocket costs can range from $10,000 to $20,000 CAD per round of IVF (Armstrong, 2022; Mahboob, 2020).

1.5.1 Types of Fertility Treatment

Fertility clinics offer various treatments and procedures to help individuals and couples overcome infertility and achieve successful pregnancies using assisted reproductive technologies (ART) such as ovulation induction, intrauterine insemination (IUI), IVF, intracytoplasmic sperm injection (ICSI), preimplantation genetic testing (PGT), gestational surrogacy, and egg or sperm donation (Lanes et al., 2020).

Of all treatments, IVF is the most successful form of ART, involving the fertilization of an egg external to the body (Doody, 2021). IVF involves stimulating the ovaries to generate multiple eggs, surgical retrieval of these eggs, fertilization with sperm in a laboratory setting (in vitro), and eventual transfer of one or more embryos into the uterus (Mayo Clinic, 2021). IVF may also incorporate eggs, sperm, or embryos from a known or anonymous donor or may involve the implantation of an embryo into the uterus of a gestational carrier (Mayo Clinic, 2021).

In addition to IVF, PGT is an additional assessment tool before embryo implantation (Jones et al., 2022). PGT for aneuploidy screening (PGT-A) screens embryos for irregular chromosome numbers, such as trisomy 21. Meanwhile, PGT for structural rearrangements (PGT-SR) examines embryos for chromosomal structural alterations, such as chromosome translocations or inversions. Furthermore, PGT for monogenic disorders (PGT-M) identifies embryos carrying specific single-gene mutations. After genetic analysis, embryos that are chromosomally normal (euploid) and/or without a particular pathogenic variant are chosen for transfer (Chan et al., 2021). The demand for PGT-A has substantially risen due to its potential advantages, including improved implantation rates per embryo transfer, reduced miscarriage risks, minimized chances of a pregnancy with an aneuploid fetus, and shortened time to conception (Bracewell-Milnes et al., 2021). In Canada, there has been an increase in the use of PGT-A every year since it was first introduced into clinical practice, with the number of PGT cycles increasing from 6.7% in 2015 to 30.7% in 2018 (Canadian Fertility and Andrology Society, 2023; Lanes et al., 2020). It is worth noting that opting for a PGT cycle entails an additional cost ranging from $3,000 to over $7,000 CAD, in addition to the expenses associated with a standard IVF cycle (*Infertility Treatment in Vancouver, British Columbia | PCRM*, 2022).

1.5.2 Third-Party Reproduction

Third-party reproduction involves utilizing donated gametes (sperm or eggs), donated embryos, or involving the support of a gestational carrier to enable another individual or couple to embark on the journey of parenthood. The availability of donor gametes and the option of surrogacy extend an opportunity to individuals and couples who might otherwise encounter obstacles in their quest to start a family (Salazar et al., 2023). The use of donor eggs has become increasingly prevalent as a fertility treatment option in Canada, with 8.3% of all ART treatment

cycles from 2013 to 2018 incorporating donor oocytes or embryos (donor sperm data not reported in the CARTR registry) (Lanes et al., 2020). The rationale for using donor eggs includes factors such as advanced reproductive age, diminished ovarian reserve, early onset of menopause, 2SLGBTQI+ families, and situations where female partners carry an X-linked genetic condition they prefer not to transmit (Dunne, 2020). Conversely, donor sperm is commonly used among same-sex female couples, transgender couples, single women, and, at times, heterosexual couples dealing with male-factor infertility or the risk of transmitting a genetic disease from the male partner (Salazar et al., 2023). In both cases, whether using donor eggs or sperm, individuals or couples can opt for donors who are either 'anonymous' or 'known' in most provinces. The process of using an anonymous donor typically involves obtaining frozen eggs or sperm from egg or sperm banks, frequently sourced from the United States (*Infertility Treatment in Vancouver, British Columbia | PCRM*, 2022). It is important to note that the *Assisted Human Reproduction Act* prohibits the sale of reproductive material in Canada, including embryos, sperm, and eggs (Health Canada, 2020). However, it is still possible to access donor eggs or sperm within most provinces in Canada, with the stipulation that any donation must be altruistic, and reimbursement is limited to documented expenses (Health Canada, 2020).

1.5.3 Professional Roles in Fertility

Fertility clinics are staffed by a range of professionals, including specialized physicians, embryologists, fertility nurses, and andrologists, who work together to provide comprehensive care to individuals and couples seeking assistance with fertility issues. Clinics may also employ genetic counsellors, psychologists, and patient coordinators for specialized support, as well as administrative staff to handle scheduling and billing. Most fertility clinics in Canada are led by reproductive endocrinology and infertility (REI) physicians (Royal College of Physicians and Surgeons of Canada, 2017).

In Canada, a REI physician is a medical doctor with extensive medical training, including a five-year residency in obstetrics and gynecology, followed by a two-to-three-year fellowship in reproductive endocrinology and infertility at an advanced educational and research institution (Physicians and Surgeons of Canada, 2017). Reproductive nurses, also known as fertility nurses, also play a large role in fertility clinics. Their duties encompass educating patients on

reproductive cycles and treatment plans, guiding medication administration, providing support during procedures, and offering guidance on third-party reproduction options (Canadian Fertility and Andrology Society, 2020).

Genetic counsellors working in fertility clinics play a crucial role in helping individuals and couples make informed decisions about their reproductive health. Genetic counsellors working in ART/infertility help assess genetic risks, advise on genetic testing, and offer insights into reproductive choices, including preconception carrier screening, prenatal testing, and PGT (Liker et al., 2019). Additionally, they provide emotional support, educate patients on the genetic aspects of fertility treatments, and collaborate closely with other healthcare professionals in the clinic. Infertility genetic counselling is a relatively new and small specialty, with the first National Society of Genetic Counsellors (NSGC) ART/infertility special interest group established in 1996 and no established community of practice within the CAGC (Liker et al., 2019). Among the 251 Canadian genetic counsellors surveyed in 2022, fifteen (5.9%) indicated they primarily worked in the areas involving PGT/ART/IVF/infertility or preconception/reproductive screening (Canadian Association of Genetic Counsellors, 2022).

CHAPTER 2: INTRODUCTION AND RATIONALE

2.1 Introduction

In response to the concerns that ethnicity-based screening provides sub-optimal risk assessment and the fact that most people born with a genetic condition do not have a positive family history, updates are being made to carrier screening guidelines around the world to recommend offering ECS routinely (Delatycki et al., 2020; Gregg et al., 2021; Sagaser et al., 2023). Canadian guidelines lag behind, with no guidance on integrating ECS into practice and continue to recommend targeted reproductive carrier screening for individuals with a family history of a genetic condition or who are of a specific ethnic background (Wilson et al., 2016).

Most reproductive healthcare providers, including genetic counsellors and REI physicians, are proponents of ECS (Briggs et al., 2018; Lazarin et al., 2016). Since their patient relationships start pre-conceptionally, FHP have a unique opportunity to integrate ECS into their practice and further, it has been speculated that emotional, financial, and physical burdens experienced by fertility patients may drive a greater interest in ECS (Martin et al., 2015). Despite these optimal conditions, there are currently no standard guidelines or recommendations to help Canadian FHP navigate the provision of ECS testing. As such, there is limited research on how often, when, and how Canadian FHP discuss ECS with their patients. Therefore, this study explores when, how and to whom this test is offered and the overall experience coordinating ECS for fertility patients.

2.2 Research Questions and Aims

This study aimed to answer the research question: What are the current practices and opinions related to ECS among FHP in Canada? The objectives of this study were threefold:

1) To explore how clinics have integrated ECS into their practice: Participants were asked how they offer ECS and their roles and involvement in discussing ECS with patients. This included successes, trends, and impacts they have observed in patients by implementing ECS.

2) To explore barriers and facilitators in offering/coordinating/discussing ECS: This included identifying current educational, counselling, and staffing resources clinics are using and what additional resources FHP feel could be helpful.

3) To explore the opinions of ECS among FHP: FHP general opinions and attitudes of ECS were explored, which included whether they believe it should be integrated into routine preconception counselling.

CHAPTER 3. METHODS

3.1 Study Design

This study followed a qualitative, interpretivist design (Figure 1. Study Design). As qualitative research is valuable in furthering our comprehension and knowledge base of the realities constructed from subjective human experiences surrounding a specific phenomenon, this approach aligned with this study's research aims to gain a deeper understanding of each participant's unique experiences and opinions with and about ECS (G. Higginbottom & Venzon Cruz, 2012). This study was an exploratory pilot utilizing an online screening questionnaire and individual in-depth semi-structured interviews to capture our participants' unique views and opinions. Participants were first screened using the online screening questionnaire to gather preliminary information about the participant and their clinic interactions with ECS. This information was then integrated into individual participants' interviews. Semi-structured interviews provided a flexible format to gain more depth and asked questions which cannot be easily quantified to gain a more profound understanding (Cleland, 2017; Higginbottom et al., 2013). Interview transcripts were analyzed for common findings using a descriptive coding process and interpreting the data to develop the overarching categories to draw conclusions from the data (Higginbottom et al., 2013).

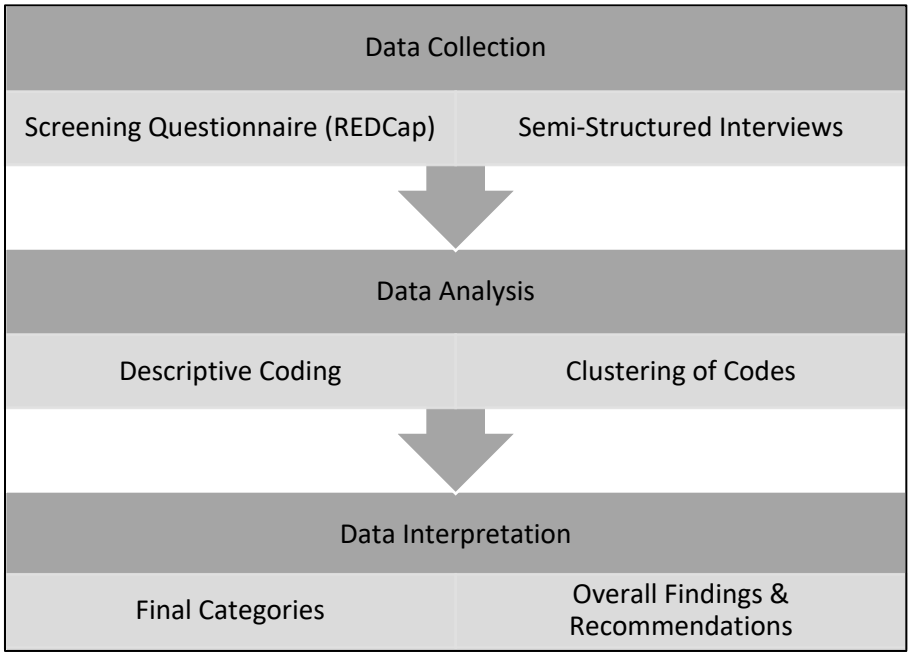

Figure 1: *Study Design*. Overall procedure used to collect, analyze and interpret interview data to generate the overall findings of the study

This study received ethics approval from the University of Manitoba's Bannatyne Campus Research Ethics Board under the approval number H2022:180 (HS25523).

3.2 Theoretical Foundations

We used qualitative description as a pragmatic approach to emphasize participants' experiences and perspectives of using ECS in the field of fertility care. Fundamental qualitative description typically adopts a naturalistic viewpoint and describes a phenomenon in its unaltered state (Kim et al., 2017). This approach aims for descriptive validity by applying a "low-inference approach," signifying that what the researcher opts to portray is something that a majority of observers would concur is genuinely present (Sandelowski, 2000). Additionally, it aims for interpretive validity, ensuring an accurate representation of the meaning's participants attributed to those events (Sandelowski, 2000). Therefore, this approach is well suited to our research aims to represent a diverse group of participants' experiences and opinions about on our pre-defined topic of ECS within the context of fertility care, and link this to knowledge and clinical experience of the genetic counselling field and ECS.

3.3 Recruitment and Eligibility

Eligible participants for this study were FHP working in the field of assisted reproduction in Canada, in line with the study's established criteria (Table 2). This study included individuals who are proficient in English, with at least one year of experience in the fertility field, who have a role in providing some form of reproductive counselling with patients (i.e., talk about pregnancy options and screening).

Table 2: Inclusion, exclusion and purposeful sampling criteria used to recruit and determine eligible participants

Inclusion Criteria
✓ Currently working in the fertility setting in Canada
✓ 1 year experience in the fertility field
✓ Counsels' patients on pregnancy testing/screening
✓ Proficient in English
Exclusion Criteria
✖ Does not counsel patients on pregnancy testing/screening (i.e., Nurses working strictly in the OR)
✖ Less than 1 year experience in the fertility field
✖ Does not work in the Canadian fertility setting
✖ Not proficient in English
Purposeful Sampling Criteria
Province participant works in
Number of years' experience in the fertility field
Credentials (i.e., MD, RN, CCGC/CGC)
Does a genetic counsellor work at the clinic?

This study aimed to recruit 10-15 interview participants, as this number is recommended to reach saturation (Fugard & Potts, 2015). In line with a qualitative description method, purposeful sampling was employed to recruit a robust representation of respondents from various provinces, roles, and experiences through professional groups (listserv and member forums), networking and word of mouth (Figure 2). Deliberately selecting participants with a unique ability to answer this study's research question aimed to provide an in-depth narratives of their specific expertise and location, and assists in obtaining broad insights and rich information (Kim et al., 2017).

Recruitment materials (Appendix A) were sent to CAGC members through e-blast (July 2022, follow-up September 2022) and posted to the Member Forum on the CFAS website in August 2022. Members receiving these materials were asked to forward the invitation to other eligible participants via snowball sampling in accordance with Higginbottom et al. (2013).

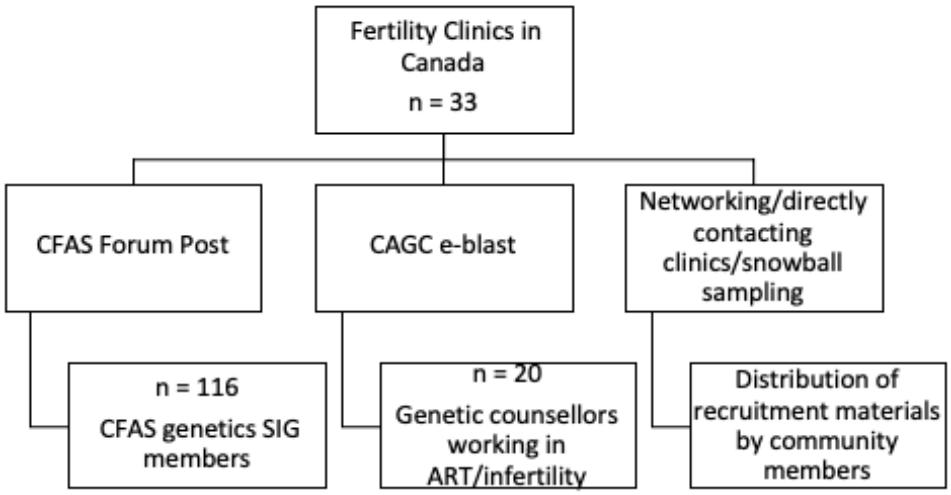

Figure 2. *Overview of Recruitment*. To recruit individuals working at one of the 33 fertility clinics across Canada, three outreach methods were used and included: 1) posting on the CFAS member forum page, 2) sending out an email blast to all CAGC members, and 3) directly contacting clinics/individuals through networking, emails/letters, and snowball sampling. (CAGC: Canadian Association of Genetic Counsellors; CFAS: Canadian Fertility and Andrology Society; SIG: Special Interest Group; ART: Assisted Reproductive Technology)

Following this initial strategy, the student (MM) primary investigator (PI) and supervisors (JNH, CCL) networked with fertility community members and current study participants to support the further distribution of recruitment materials. In addition, the student PI directly contacted 11 Canadian fertility clinics and physicians by email and letters using contact information from publicly available websites or the CFAS membership directory.

Screening Questionnaire

Those interested in participating in the study were screened using the Online Screening Questionnaire to gather preliminary information about the participant and how their clinic interacts with ECS (Appendix B). This questionnaire was developed and delivered through the secure web-based application Research Data Capture (REDCap) hosted at the University of Manitoba (Harris et al., 2009). Interested participants were emailed the online consent disclosure statement (Appendix C), which preceded the REDCap screening questionnaire link.

The purpose of the screening questionnaire was to 1) confirm the participant met the inclusion criteria, 2) aid in purposeful sampling, and 3) collect basic information about ECS practices to integrate into their semi-structured interview. Survey data collected from the screening

questionnaire from individuals who did not participate in an interview was not used in the study and was destroyed.

Interviews

The semi-structured interview guide (Appendix D) was constructed by conducting a literature review, reviewing published interview guides, and consulting with experts in the fertility field. The two guiding topics of the interview guide explored 1) participants' overall opinions on ECS and 2) the challenges and resources participants have encountered or needed while integrating ECS into their practice. Preliminary information about the participant and how their clinic interacts with ECS gathered through the screening questionnaire was integrated into the interview approach. The interview guide started with questions about clinic practices and policies and continued with questions exploring more personal thoughts, beliefs, and experiences after establishing rapport.

The interview guide was reviewed by co-supervisors (JNH and CCL) and before conducting interviews. Before conducting interviews, the student PI met with a student advisory committee member (MD) at the University of Manitoba with qualitative research expertise to discuss appropriate interviewing techniques. A pilot interview was conducted with an FHP member meeting the study criteria (who did not participate in the study). The piloted interview was reviewed by co-supervisors (JNH and CCL) and advisory committee members. The student PI was provided guidance and feedback on interviewing and probing techniques by a committee member (MD), which were integrated into the interview approach moving forward. Following the first four interviews, the student PI and co-supervisors (JNH and CCL) reviewed audio recordings and transcripts, and minimal revisions were made to the interview guide.

The student PI conducted all interviews via Zoom videoconference platform (Zoom Video Communications, Inc, 2022). At the beginning of each interview, the student PI obtained informed consent using the consent form(s) detailed in Appendix C.

3.4 Qualitative Data Analysis

Transcription

The student PI transcribed the initial four interviews to instill trustworthiness and familiarize themselves with the data. The seven remaining interviews were transcribed using Transcript Heroes Transcription Services (Transcript Heroes Transcription Services, 2023). All transcripts obtained from Transcript Heroes were audio-verified by the student PI for accuracy. Transcripts were de-identified by removing names, genders, pronouns, clinic names, and locations, and each interview participant was assigned a randomly generated study ID to maintain confidentiality.

Coding and Analysis

Data analysis was conducted as per an approach by Miles & Huberman (1994), and the student PI and co-supervisors met at different stages of the coding and analysis process, as outlined in Figure 3. The student PI and co-supervisors sorted through the data to identify similar phrases, patterns, themes, sequences and important features, which aided in developing the final code book. This also included two transcripts being co-annotated by the student PI and a co-supervisor (JNH) to ensure trustworthiness. Insights and reflections on the data were recorded through memoing by the Student PI throughout the analysis process. In addition to this, the data were analyzed for commonalities and differences and extracting them for further consideration and analysis. Following the establishment of codes, the student PI and co-supervisors grouped codes reflecting similar concepts or ideas together using a process referred to as axial coding. Constructs and concepts emerged as the data from these clusters were analyzed further, eventually developing categories and generalizations that hold true for the data. The participants' responses to the initial overarching research questions were formed, and concrete recommendations were developed in light of the existing knowledge and practice of ECS in Canada.

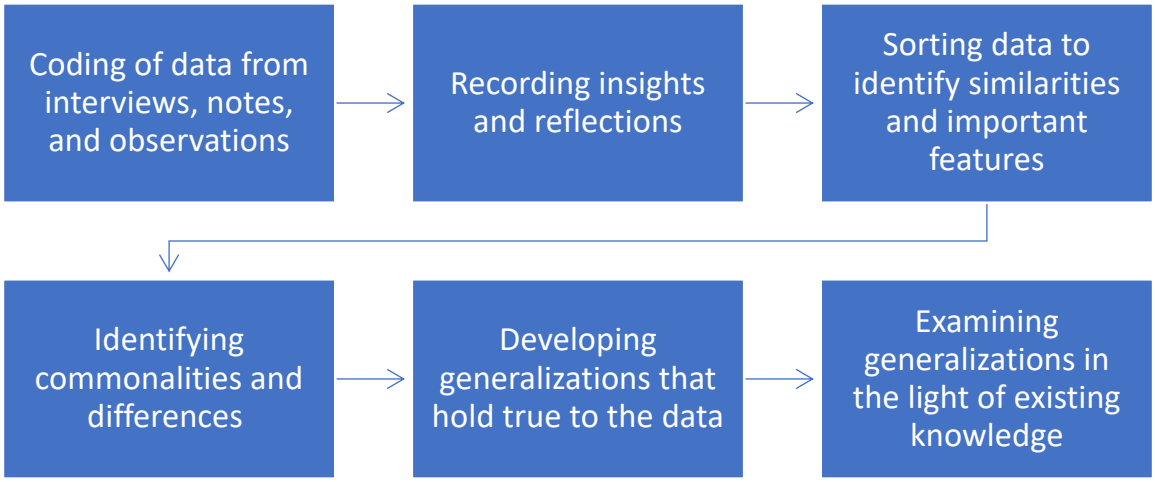

Figure 3. *Analytical Steps of a qualitative descriptive approach (Adapted from Miles & Huberman (1994))*

Data Saturation

Dedoose software (Dedoose version 9.0.85, 2021) was used to analyze trends in the data by reviewing the frequency codes applied per each participant interview and data saturation of code application. While no set sample size is needed in qualitative research, Fugard & Potts (2015) recommend a sample size of at least seven participants to reach theoretical saturation, a with a prevalence of at least 80% for thematic analysis in qualitative research. Participants were interviewed until saturation was reached through an iterative process with ongoing data analysis relating to the study's overall research aims and objectives (Plaza Del Pino et al., 2013).

Trustworthiness and Rigour

Maintaining research rigor relies heavily on a conscious and reflective approach because the researcher acts as the human instrument, inevitably influenced by personal biases, preconceptions, and their unique perspective on the world, all of which can impact the research process (Cohen & Crabtree, 2008; Higginbottom et al., 2013). This study employed several

strategies to ensure the credibility, reliability, confirmability, and transferability of the participants' voices (Ravitch & Carl, 2021, Chapter 6).

Credibility in this study was established through several means. Prolonged engagement was achieved through extensive observations and interactions with participants. The student PI transcribed four interviews and carefully reviewed audio recordings and transcriptions multiple times. Peer debriefing with co-supervisors (JNH and CCL) occurred consistently throughout data collection and analysis, with co-supervisors serving as a critical checkpoint to validate the student PI's insights. Data triangulation was another vital aspect, with the student PI purposefully sampling data from diverse sources, ensuring participants had varied experiences and backgrounds. This approach allowed the student PI to analyze data from multiple perspectives as well as consider any outliers (Guba, 1981). Additionally, co-supervisors cross-checked the data, offering an alternative viewpoint.

To maintain the dependability of the data analysis process, several measures were taken. An audit trail was diligently maintained, and the research team (MD, CCL, JNH) reviewed the codebook and descriptions. Furthermore, to ensure the reliability of the process, two transcripts were collaboratively annotated by the student PI and the supervisor (JNH). Dependability was further assured through ongoing meetings between the student PI and co-supervisors during both data collection and analysis. These discussions aimed to identify and address any potential biases that might distort the results and to resolve any differences in interpretations. Moreover, the design and pilot of the interview with an external FHP was instrumental to ensure that the research methods aligned closely with the study's objectives, adding an extra layer of dependability to the findings.

To establish confirmability, the student PI actively recognized that qualitative research lacks inherent objectivity. In line with this understanding, reflexive processing methods were employed to ensure the findings of this study could be confirmed (Guba, 1981). This approach encompassed the maintenance of a reflective journal in which the student PI systematically explored their preconceived biases, positionality, and thoughts throughout the entire data collection and analysis process. Following each interview, the student PI engaged in reflective exercises, contemplating aspects such as interview style, language usage, and notable interview

moments. Moreover, the practice of memoing was consistently employed during the data analysis phase to document the evolving understanding of the data and the generation of results.

To enhance the transferability of this study's findings and interpretations, the student PI made deliberate efforts to supply comprehensive and robust information. This was achieved through purposeful sampling and the collection of rich, descriptive data, allowing readers to assess the applicability and transferability of the findings to analogous situations or settings (Guba, 1981; Tracy, 2010). Purposeful sampling was employed to maximize the diversity of data collected, thereby broadening the potential for transferability. Additionally, rich descriptions of the data were provided to ensure the study's context was both authentic and well-defined (G. M. A. Higginbottom et al., 2013). This approach involved conducting an in-depth analysis of the commonalities and distinctions within FHP compared to other specialties. Furthermore, it entailed providing rich contextual descriptions pertaining to fertility patients and the specific work environments of the participants (Ravitch & Carl, 2021, Chapter 6).

In summary, detailed methods were employed to ensure the trustworthiness and rigour of the findings in this study. Maintaining research rigour demanded a conscious and reflective approach through the establishment of creditability, dependability, conformability, and transferability. Overall, these methods contributed to ensuring our results and findings are an accurate representation of the data collected from participants (Cohen & Crabtree, 2008; Tracy, 2010).

3.5 Positionality Statement

In conducting this qualitative study on the experiences of FHP, it is imperative to acknowledge the positionality of the researcher. The student PI in this study brings a unique background and set of experiences that influenced the approach, perspective, and interpretation of the study's findings. Before embarking on this research, the student PI worked as a genetic counselling assistant in a fertility clinic, which afforded them valuable insights into the intricacies of patient care, such as the challenges faced by individuals seeking fertility treatments, and the nuances of workplace interactions and genetic counselling in this context. The student PI's experiences in this clinical setting have informed their research interests and motivated their desire to explore this topic in-depth. During the study, the student PI was

pursuing their MSc in Genetic Counselling degree. While they had limited direct experience in counselling patients on carrier screening, their training provided them with a comprehensive understanding of the genetic aspects of reproductive health. The student PI is aware that their background in genetic counselling and prior fertility work experience may introduce biases and preconceptions that could influence the research process and the way they interpret participants' narratives. To mitigate this, the student PI tried to maintain a high level of reflexivity throughout this study using the approaches described above and continually reflected on how their background and experiences may have impacted their interactions with participants, data analysis, and the overall approach to the research.

CHAPTER 4. RESULTS

4.1 Screening Questionnaire Results

The demographic characteristics of participants are summarized in Table 3. Fifteen individuals ultimately expressed interest in participating in this study, and eleven interview participants were recruited, including five genetic counsellors and six REI physicians. Among the 251 Canadian genetic counsellors surveyed in the 2022 professional status survey (PSS), nine primarily worked in the areas involving PGT/ART/IVF/infertility, while six stated they worked in preconception/reproductive screening (Canadian Association of Genetic Counsellors, 2022). Therefore, it is estimated at least 15 genetic counsellors work in fertility in Canada, giving a response rate of 5/15, or 33%. There are approximately 51 REI physicians in Canada (Canadian Medical Association, 2019), with a response rate 6/51, or 11.7%. Interview length times ranged from 18.36 – 58.70 minutes, averaging 34.37 minutes. The study included participants practicing in Ontario, Nova Scotia, Alberta, Manitoba, British Columbia and Quebec, which represent the majority of provinces with a fertility clinic, except Saskatchewan and New Brunswick. All individuals interviewed practiced at clinics that offered ECS, with two participants working at a clinic that did not have a genetic counsellor on staff.

Table 3. Results of Screening Questionnaire

	Total (n = 11)	%		Total (n = 11)	%
Credentials			ECS test offered*		
Physician	6	54.5%	Invitae	11	100%
REI/OBGYN	5		Fulgent	1	9.1%
Geneticist	1		Sema4	0	0%
Genetic Counsellor	5	45.5%	LifeLabs	0	0%
Nurse	0	0%	Other	0	
Other	0	0%			
Years' Experience			ECS PRE test counselling provided by*		
1-4 years	4	36.4%	MD	7	63.6%
5-10 years	4	36.4%	GC	8	72.7%
10-15 years	2	18.2%	Nurse	0	0%
15 + years	2	18.2%	Other	1 (GCA)	9.1%
Clinic offers ECS			ECS POST test counselling provided by*		
Yes	11	100%	MD	6	54.5%
No	0	0%	GC	11	100%
			Nurse	1	9.1%
			Other	0	0%

* total does not sum to 100% as participants could select more than one option

4.2 Qualitative Findings

The exploration of FHP experiences and perspectives on ECS revealed four significant categories (Figure 4). The initial category, "Clinic Practices and Policies," sheds light on participants' existing practices related to ECS within their clinics. The second category, "Barriers and Challenges," articulates the primary obstacles faced by participants in delivering and making ECS services accessible. The third category, "Fertility Provider Culture Shapes ECS Practices," delves into FHP viewpoints on ECS and the diverse factors influencing its integration. Lastly, the fourth category, "Changes and Recommendations: Enhancing ECS Delivery," showcases the

areas where FHP believe improvements could be most beneficial for enhancing the provision of ECS within fertility clinics. Saturation was achieved after interviewing 11 participants. These four categories emerged consistently throughout all participant interviews, which were identified by evaluating each interview's code application, detailed in Figure 5.

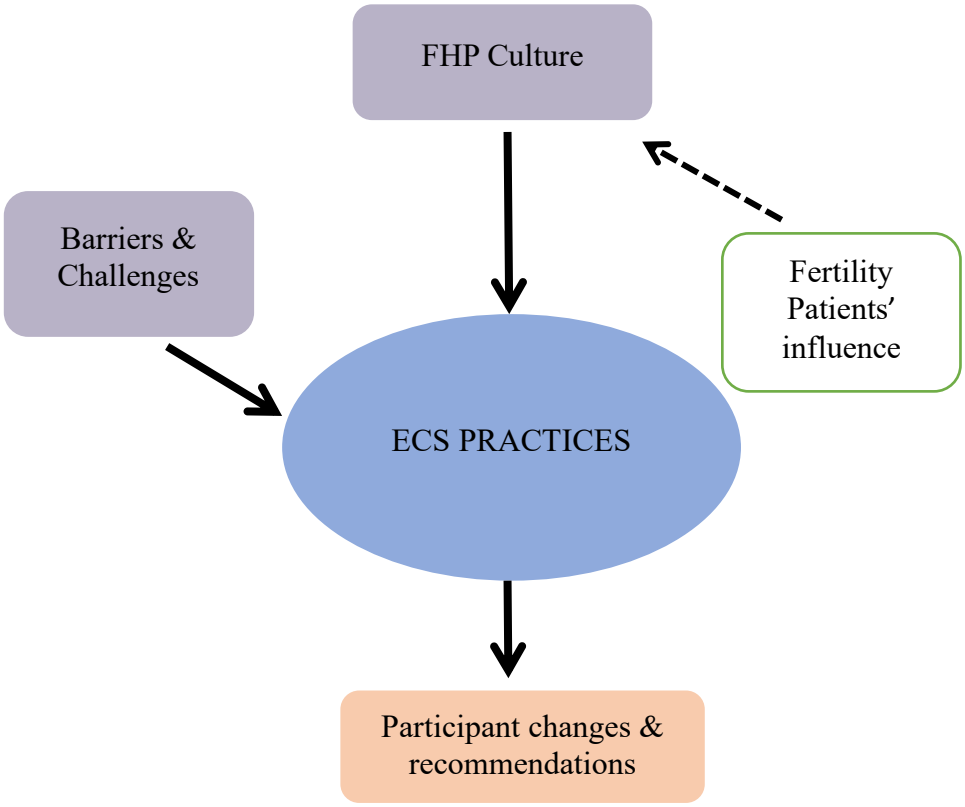

Figure 4. Overview of the four main categories

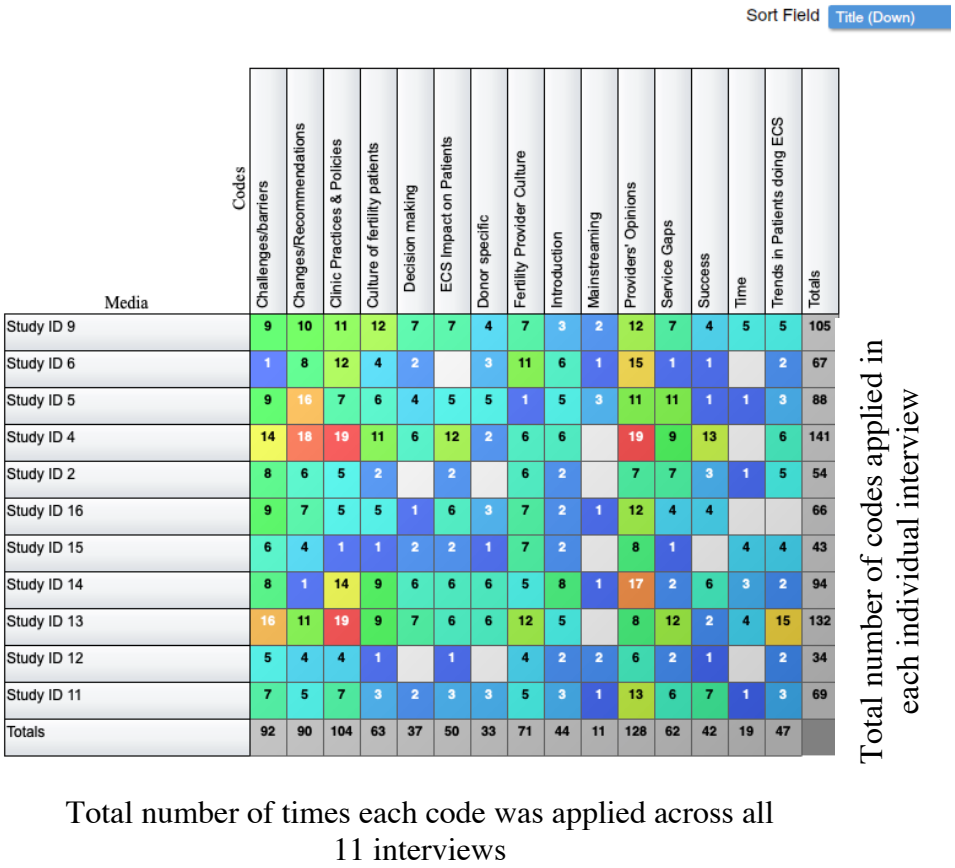

Figure 5. *Code Application across Interviews in Dedoose demonstrating the reoccurrence of codes used in interviews*. Squares in red, yellow, and orange highlight the most frequently used codes. Squares in grey on the x-axis display the total number of times a code was used across all interviews. Squares in grey on the right y-axis display how many codes were applied to each independent interview.

4.2.1 Category One: Clinic Practices and Policies

Clinic practices and policies were a key topic discussed by all participants during their interviews. Firstly, participants discussed how patients gain information about ECS; this includes how, when and to whom the topic of ECS is introduced, and the various methods employed for counselling and education about ECS. Secondly, participants discussed how resources such as genetic counselling services, testing laboratories, and other staff members contribute to integrating ECS at their clinic.

ECS is Introduced to Patients Inconsistently

To understand the current practices of ECS within fertility clinics across Canada, participants were asked to describe how the topic of ECS is introduced to patients and practices surrounding which patients are offered ECS. Participants described a variable approach with clinic-specific processes.

Two participants stated that ECS is consistently offered to all fertility patients that come through their clinic:

> *Every patient who meets with one of our REIs, so our fertility physicians, will hear about expanded carrier screening in their first review appointment. So, it's not the first thing that they hear about when they're first coming to the fertility clinic, but it's kind of introduced as an option after that first review – ID5, Genetic Counsellor*

> *It's usually offered twice. Once as a general overview when they come in as part of things that you can do to assure a healthy pregnancy. And then, if it isn't picked up or determined at that point, it's usually brought up again, if they're coming towards IVF and considering doing PGT-A. – ID6, Physician*

In contrast, others only focused on offering this test for those using donor gametes or who are an already identified carrier.

> *I think it's offered to all of our patients who are using donors. So, if they're using sperm donors or egg donors, then it's definitely offered to all of those patients. – ID9, Genetic Counsellor*

Some clinics described a systematic approach to introducing ECS, including educational information alongside routine family history intake forms.

> *Right now, any new patient, as soon as they're referred, they get a kind of one-pager family history screen, so they can answer some questions about their family history. And on the second page is information about expanded carrier screening and a group education session that we run about it. – ID4, Genetic Counsellor*

However, other participants noted that their clinic does not routinely introduce ECS to all patients, unless patients actively request information. In these cases, counselling and education about ECS are often available but require the patients to do their research and make a request.

> *I think it depends on how you define "offered". It's not something that's currently being actively discussed at every new consultation. Or every genetic counsellor meeting. But it is available to all patients should they decide to do it based on their own research, or*

> *looking on the website, or after their conversation with the doctor or genetic counsellor. – ID15, Physician*

For most participants, it was described that the choice to introduce ECS to patients largely depends on the treating physician's preference.

> *I've never actually asked all the physicians why they wouldn't offer it to everyone, but from the conversations I've had, that's really what it is. Is that like they determine themselves as the physicians determine themselves, if they think this couple should be offered it or not? – ID9, Genetic Counsellor*

> *Well, it's offered by the doctor; the doctor you know remembered talking about it during the patient encounter. This is the main thing. Now, to be honest, it's not very often discussed, OK, probably depending on – each doctor has his – and if he remembered to talk about it, but there is no systematic offer for that for the patient. -ID12, Physician*

The manner in which patients were provided education about ECS varied across participants and was most often dependent on their clinic practices. Participants described using different approaches to share information with patients, including hosting materials on their website or patient portal, having a pamphlet, and incorporating it into their clinic's welcome information package.

> *I think patients are aware it's available. We have it on our website. We have it on our pamphlets. We have it kind of all over the place. – ID14, Physician*

> *It just comes in a package from the admin staff. – ID4, Genetic Counsellor*

> *We made a video to explain. So, they know that it exists. Because the donors are tested for that, and then the nurse says, "Well, there are options. You can see a genetic counsellor to discuss". We made a video prior to the [genetics] consultation for [patients] to have a better idea, and we have pamphlets for patients. – ID11, Physician*

Several participants, both genetic counsellors and physicians, stated that they introduced the topic of ECS during broader fertility consultations with patients. A few physicians voiced that they introduce basic information on ECS to the patient, including a resource containing information about how to connect with the clinic's genetics team for pre-test counselling.

> *I say to them, "if you're interested in expanded carrier screening, I'm going to give you some information, and it'll tell you what you can do if you want to pursue it". – ID6, Physician*

Two genetic counsellor participants said they always mention ECS with patients during their PGT sessions.

> *It would also come up any time someone meets with a genetic counsellor to talk about pre-implantation genetic testing. We offer expanded carrier screening, and kind of have a counselling session about it at the end of our PGT sessions. – ID5, Genetic Counsellor*

On the other hand, many participants defined a more consistent approach to providing education about ECS for patients using donor gametes. Participants described that in the donor gamete setting, the topic of ECS is usually introduced early in the process, as patients will often see donors identified as carriers through the bank (often referred to as a genetic flag) and require more information before making a decision.

> *The vast majority of [donors] have what we call a genetic flag, so they are carriers of something, and when they're carriers of something, [patients] ask for a genetic consultation every time. So, we see a lot. Almost every patient who wants to use an egg or sperm donor has to see me or the two genetic counsellors. – ID11, Physician*

Additionally, the majority said patients who are selecting donor gametes are provided information on carrier screening to help this process. A staff coordinator is often designated to help in third-party coordination (for any patients using donated eggs, sperm, or embryos). For clinics with a genetic counsellor, participants said their patients are typically connected with the Genetics team if their donor has a flag.

> *We had made a pamphlet explaining what carrier screening is and why we do it. And we've incorporated a carrier screening sort of blurb into our info on donor sperm, donor egg – our pamphlets on donor sperm and donor egg talk about carrier screening as well. – ID14, Physician*

> *Anyone who is using a donor gamete will have information given to them by our third-party coordinator about expanded carrier screening. They have the option to have a counselling session before going forward. – ID5, Genetic Counsellor*

> *They're connected with the donor and surrogacy team, which includes the nurse coordinator and genetic counsellor. And we meet with them early on because they may have a lot of decisions to make, but we kind of introduce the concept and then depending on whether they use frozen or fresh or somebody they know, we revisit and offer it again – ID4, Genetic Counsellor*

On the other hand, physicians at clinics without genetic counsellors were more comfortable navigating donor flags and coordinating ECS; and described providing genetic counselling about carrier screening with patients frequently in their practice.

> *I have that conversation with them upfront and say, "Go online first; look to see what the donor pool is. If you find a donor who has nothing" – who is actually very rare, but there*

> *are a few –"if you find a donor who has nothing of interest, then don't do carrier screening because it's not going to change your life"... I would say I have this conversation probably five or six times a week if not more. I have it at least once a clinic. – ID14, Physician*

In summary, participants described a consistent approach to offering ECS in the gamete donation setting, especially when genetic flags are already identified. Otherwise, the participant responses highlighted inconsistencies in how ECS is offered across clinics, or sometimes within clinics. While all clinics had defined workplace practices in place for patients using donors to assist in discussing and coordinating ECS for those patients, practices for non-donor patients were more arbitrary and often up to the physician's discretion. Though all clinics had information available to patients in some form, only two clinics consistently offered and discussed ECS with all fertility patients.

Staff Roles and Strategies in Implementing, Educating, and Coordinating ECS are Inconsistent Across Clinics

Participants discussed different healthcare providers who make up a team to introduce, provide counselling and education, and coordinate ECS at their clinics. Most participants worked at a clinic with at least one genetic counsellor on staff (Table 3. Results of Screening Questionnaire). The number of genetic counsellors per clinic ranged from one clinic having a part-time genetic counsellor one day every second week, to others having upwards of at least three in-house genetic counsellors. Many of the genetic counsellors interviewed were the first person hired in their position.

> *So now we have two genetic counsellors, but I used to be alone at the beginning. – ID11, Physician*

> *I was the first genetic counsellor at the clinic – ID4, Genetic Counsellor*

Most physician participants with genetic counsellors on staff referred all genetic-related consults, and noted this process works well for them, as physicians and patients are able to utilize genetic counsellor services relatively seamlessly.

> *We have our two genetic counsellors in-house ... It's easy for me if I want to ask [the genetic counsellors] to take care of something, they will do it. – ID12, Physician*

> *Mostly they go through the genetic counsellor first… I can't comment directly on their workload. But from my perspective, am I hearing back from patients like, "I can't move*

> *forward because I can't get into a genetics counsellor for expanded carrier screening?" I mean, no, I'm not hearing that. – ID6, Physician*

For the two participants without an in-house genetic counsellor, these physicians managed all pre and post-test counselling for ECS results, including discussing residual risks and helping patients select a donor. One participant felt their physician team could handle all ECS-related undertakings as the clinic workload was insufficient to warrant hiring an in-house genetic counsellor. The other participant stated they consult with a specific Clinical Geneticist when needed.

> *I don't think we have enough volume – I mean, I know we do a lot of carrier screening, but I don't know that we have enough volume to have a genetic counsellor consistently in the clinic. – ID 14, Physician*

> *Right now, when the [ECS] results come in, we basically just try to call the patient at the end of a clinic day and try to just reach them…We refer to a specific geneticist who has a genetic counsellor. They don't specifically work for us, but [we] work very closely in conjunction. – ID13, Physician*

Many participants mentioned various staff members, in addition to genetic counsellors and physicians, who play a role in the coordination of ECS tests, which include nurses, a genetic counselling assistant (GCA), and a patient care compliance coordinator. Further, others described their clinics as having technicians or nurses who perform ECS phlebotomy and nurses designated to assist with all third-party (donor) reproduction patient needs.

> *One of our nurses manages the donor egg stuff, and one of our other nurses manages the Canadian Compliance – the SSOR stuff…[We] also have a patient care compliance person, who is more of an administrative person, and they are the one who makes sure all the paperwork is intact…and gives me the communication or risk forms and says, please fill this in. – ID14, Physician*

> *[The GCA] sends the consent form, make sure it's signed, facilitates shipping the collection kits, or coordinating with the laboratory. – ID4, Genetic Counsellor*

> *Our third-party coordinator is also sort of a genetic counselling assistant… And that's been very helpful to have someone who is trained in the ordering of the testing. Helping coordinate that side of things. Consenting and first introducing the topics, I think, really helps the flow of things. – ID5, Genetic Counsellor*

As seen in the screening questionnaire data results (Table 3), all participants used the same ECS laboratory, with one clinic offering a choice between two different testing companies. Nearly all participants preferred this particular laboratory because of a user-friendly online

platform to order testing and track results, making the process straightforward. In addition, a few participants pointed out that this laboratory's reproductive summary reports for couples were beneficial and timesaving. When only offering a test from a single laboratory was explored, some participants felt it was simpler to offer one choice to limit confusion or extra work.

> *I think the [reproductive summary] reports are a big place that makes a big difference both from the provider and the patient perspective. So, when both partners are linked to one another, they can actually calculate the reproductive risk and show both of the results in a nice little summary and calculate the residual risks, which is really helpful… [The laboratory] does all of that math for you as the Genetic Counsellor. That makes my job a lot easier. – ID4, Genetic Counsellor*

> *We get a constant supply of kits for blood draws, so they'll usually just take it to our phlebotomy lab, and the phlebotomy lab will mail it out. And our nurses will order the testing online… [the testing laboratory] is quite easy to order online, so they'll just order the testing. – ID9, Genetic Counsellor*

Interestingly, most participants were aware of the ECS laboratory's in-house genetic counselling services and that patients could use them if needed, but few utilized them. One participant said they were uncomfortable using the laboratory's genetic counselling services.

> *I could ask my colleagues how much they've used [the laboratory's genetic counsellor services] lately, but I think most of the time we're comfortable doing the sort of more basic counselling just on results. If it's something more complicated, so far, we've felt more comfortable with it being our genetic counsellor and geneticist that's associated with us. – ID13, Physician*

One clinic with a part-time in-house genetic counsellor relied on the ECS laboratory services to help supplement their genetic counselling service.

> *[The ECS laboratory] has their own genetic counsellors. And so oftentimes, our clinic will refer to [the ECS laboratory] and to me. And then whoever gets to them first they'll cancel the other appointment. Because I do work part-time and I'm the only genetic counsellor there. So sometimes patients wait, you know, four weeks to see me because that, to me, is not as urgent. – ID9, Genetic Counsellor*

Participants discussed the involvement of various staff members' involvement in introducing, providing counselling and education, and coordinating ECS at their clinics. In most cases, clinics had in-house genetic counsellors, with varying numbers per clinic, who played a pivotal role in genetic-related consultations and ECS post-test counselling. However, a couple of participants managed all ECS-related tasks without an in-house genetic counsellor, either

handling post-test counselling themselves or consulting with external geneticists and genetic counsellors when needed. Genetic counsellors and physicians are supported by other staff members, including nurses, GCAs, patient care compliance coordinators, technicians, and nurses designated for third-party (donor) reproduction patient needs. Participants primarily used the same ECS laboratory, citing its user-friendly online platform and reproductive summary reports as valuable, but rarely used their genetic counselling services.

In conclusion of category one, participants described a varied approach within and between clinics, with only two clinics consistently offering and discussing ECS with all fertility patients. However, all clinics appeared to have a more defined practice for patients using gamete donors. How patients were educated about ECS also differed among clinics, with some providing more passive information (on their website, pamphlets) and others having a more active approach, such as offering group educational sessions and informational videos. Those without an in-house genetic counsellor shed light on some unique clinic practices and staff roles taken on to offer ECS. Overall, there were inconsistencies in how ECS was offered across clinics, with some standardization in the donor gametes setting, highlighting both consistency and disparities in ECS practices across fertility clinics in Canada.

4.2.2 Category Two: Barriers and Challenges

Participants highlighted multiple challenges and barriers that hindered the provision and accessibility of ECS services and information in fertility clinics across Canada (Table 4). During the analysis of interviews, four key issues consistently emerged. Firstly, the availability of genetic counselling services was identified as a crucial component for delivering ECS effectively, but participants noted limited access to reliable genetic counselling resources as a significant hurdle. Secondly, time constraints and competing clinic priorities posed challenges in prioritizing the integration of ECS into their practice. In addition, both the absence of standardized guidelines and professional recommendations for ECS, and finally, the fact that it is an out-of-pocket expense for patients, further complicate the ability of FHP to offer ECS services with confidence.

Table 4. Challenges and barriers of integrating ECS within Canadian fertility clinics cited by study participants

Barriers cited	*Participant Description*
Limited access to genetics services	There are not enough genetic counsellors, in both the provincial system and private sector, to be able to support offering ECS to all fertility patients.
ECS is not a priority for fertility clinics	ECS is not a top priority or focus within the fertility setting, making it challenging for clinics to prioritize changes/improvements with implementing ECS.
There is no standardization to ECS practices	Absence of professional guidance and outdated practice guidelines have left FHP unsupported in providing ECS care, resulting in inconsistencies on how ECS is being offered across and within clinics.
ECS is an added expense for both fertility patients and clinics	Costs for genetic counselling services, clinic fees, downstream costs of PGT, plus compensation for services such as in house blood draws, shipping, and paying their staff, are additional expenses that hinder the accessibility of ECS.

"We could use more genetic counsellors": The Delivery of ECS Needs to be Complemented by the Genetic Counselling Workforce

Genetic counsellors and physicians discussed various challenges they have experienced with carrier screening at their clinic. Some physicians who had in-house genetic counsellors stated they did not feel comfortable discussing ECS. Some felt it is beyond REIs expertise to handle ECS results and expressed the need for genetic counsellors in order to offer this service.

> *If I knew that it wasn't going to come back to me to answer questions on these rare genetic disorders. That's really not within my realm of specialty. Because it's not that physicians are lazy and don't want to talk about this. It's that we don't know, right? We don't know about I would say most of the disorders on the list. So, it's not appropriate to have a gynecologist counselling about a rare neurological disorder, for example. – ID15, Physician*

> *If you don't have access to counselling from the company itself at least, or from the clinic, you probably shouldn't order the test because, you know, as an REI you don't have the capacity to do a full counselling [session]. – ID12, Physician*

Even with in-house genetic counselling support, it would not be enough to support offering ECS to all fertility patients. Leading to a reluctance to routinely offer ECS to all patients without adequate genetic support or an established route to refer patients to outside genetics services.

> *Because if you offer it to everybody, not only does it take time in the initial counselling, it takes time by genetic counsellors. Of which there are too few in the publicly funded system to support this. – ID15, Physician*

Genetic counsellors expressed motivation to improve the ECS process within their clinics but stated that support from the physicians at their clinic is needed to implement change. The majority of genetic counsellors mentioned that inconsistencies in how ECS is being offered may be due to physicians' limited awareness of the implications and its low perceived priority. Some genetic counsellors expressed feeling obligated to educate the physicians they worked with so they could fully appreciate the benefits of ECS.

> *Then of course everyone has full clinic loads and so thinking about things like [ECS] sometimes gets put to the back burner. – ID5, Genetic Counsellor*

While participants in clinics indicated their current workflow was manageable, it was expressed that a barrier to implementing routine ECS is not having enough (or any) genetic counsellors in their clinics, and/or long wait times for the provincial programs incongruent with fertility patient needs. Specific concerns were mentioned in access to provincial services particularly regarding ECS results that have health implications or warrant more genetics expertise, such as implications for relatives and genes where carrier status can have health implications. For those working without an in-house genetic counsellor, this concern about waitlists was only compounded.

> *We could use more genetic counsellors out here in [Province] in general. [The Provincial] Medical Genetics waitlist is long. I think it is everywhere, but it's worse here… Here it's going to be three to six years. - ID14, Physician*

Additionally, a few participants expressed challenges using genetic counselling services from the ECS laboratories or donor companies, including unsuitable turnaround times and language barriers.

> *Although there is some genetic counselling offered through the bank sometimes, I would say it hasn't typically come with good feedback on sort of timeliness of it and how*

> *extensive it is to actually make a decision quickly on what donor you're picking. – ID13, Physician*

> *In an ideal world, the patient would discuss with the doctor and then be seen in genetics and then we can explain the limitations. If we cannot, then for sure, [the ECS Laboratory] counsellors could help with this part, but I don't think they offer [counselling services] in French. – ID2, Genetic Counsellor*

One participant mentioned that although the ECS laboratory genetic counselling services are available, their patients preferred to use the fertility clinic's in-house genetic counselling services.

> *I do find that the patient will often rely mostly on [the clinic] for the counselling because we're maybe their more immediate contact. Maybe they trust us more, maybe they know us, they've met us. Maybe we're easier to get a hold of, I don't know what the reason is. – ID15, Physician*

In summary, participants described the complementary skillsets of physicians and genetic counsellors, which can be used to offer ECS in the fertility clinic. However, participants mentioned there is limited access to reliable genetic counselling services among existing fertility clinic staff, and there is a reluctance to rely on external genetic counsellor services, such as those available through testing laboratories.

"Fertility clinics have a lot of things to do, and I don't know if ECS is ever going to be on the top of their list.": There is Value in this Test, it is Just a Matter of Priority

Most participants expressed time or priority constraints as a reason why ECS was not offered routinely to all patients. Many participants mentioned these constraints affected all aspects of the discussion, including introducing ECS, pre-test counselling, post-test counselling, and reviewing the results. Overall, many felt ECS would never be a top priority or focus in the fertility setting, given that the primary outcome of success is achieving a pregnancy. All participants cited that fertility physicians are already juggling other important clinic tasks and often do not have the space to include ECS in their consultations.

> *I think fertility clinics have a lot of things to do, and I don't know if ECS is ever going to be on the top of their list. I think they do it because, you know, they've learned about it. They read about it. – ID9, Genetic Counsellor*

> *I like that it's available for patients as a service. But given the constraints on my time personally I don't have time to take on the counselling that's required to really appropriately inform patients. – ID15, Physician*

For the genetic counsellors, ECS is only one aspect of their position, and they described prioritizing much of their time on activities aligning with achieving a pregnancy, such as coordinating PGT and genetic testing for egg and sperm donors (genetic flags, family history or consanguinity). They acknowledged that in the current model, seeing a genetic counsellor may not be possible for all patients pursuing ECS.

> *We cannot meet [with] all patients in fertility just to offer carrier screening, so we need to kind of leave it in the hands of the doctors because if they don't refer patients to us then we won't have access to them. – ID2, Genetic Counsellor*

Some participants described the limitations of this approach, as information provided by someone other than a genetic counsellor about ECS may be sub-optimal.

> *We kind of rely on the physicians and nurses to do that pre-test counselling. I know it's not getting done sufficiently or sometimes not at all... I fully understand that it's not the best way to deliver genetic care. But at the same time, somehow the information is getting to the patients. – ID9, Genetic Counsellor*

In summary, ECS is not a top priority for FHP, many participants acknowledge the value in the test and the surrounding issues with integrating ECS into their practice. However, ECS is not considered needed to accomplish what fertility clinics prioritize - achieving a viable, healthy pregnancy.

"I don't feel appropriately guided": There is No Standardization to ECS Practices

The decision to offer ECS was reported to be physician-dependent for the majority of clinics. Participants described that most clinics do not have a standardized approach on when and how to offer ECS, and the approaches differ both between physicians and clinics. All genetic counsellors discussed inconsistencies in how ECS is currently offered, as the decision to introduce this topic in an appointment is based on the physician's preference.

> *I think there's just a lot of inconsistencies in what the physicians are offering. You know, maybe it's different awareness? Maybe some of them aren't as aware as some of carrier screening? Or it's not on their radar? Or they don't see the utility of it? – ID 16, Genetic Counsellor*

Genetic counsellors noted an absence of professional guidance and outdated practice guidelines made them feel unsupported and wonder if their approach to ECS is fair and consistent.

> *Carrier screening is probably my least favorite thing because I never feel like I'm doing a good job with it because I don't feel adequately supported. I don't know what the best route is. I don't know what the best panel is. I don't feel appropriately guided, and I've just always felt a little bit lost. -ID4, Genetic Counsellor*

The majority of clinics described a rather impromptu method of handling ECS results, and most participants noted that a more sustainable method was needed.

> *We're at that point though, where it's not sustainable for us to be doing these sorts of random [ECS results] calls urgently. I think we're trying to figure out a process that makes us less involved in the process. But I don't think we've really come up with a new process yet. – ID13, Physician*

One participant specifically noted the public versus private divide as it relates to their practice, as the provision of fertility care occurs in the private sector. In contrast, Canadian genetic testing guidelines are meant to be applied in the public sector.

> *From a public standpoint? Yeah, I mean I would love if there was a guideline that said this is what we should be offering every patient. Because the problem is, from a public testing standpoint, I do probably offer more carrier screening than most counsellors do. – ID16, Genetic Counsellor*

Several participants conveyed uncertainty regarding the optimal timing to introduce ECS to patients during their fertility journey. They raised concerns that introducing it too early could overwhelm patients with information, leading to its potential to be forgotten or not fully understood. Additionally, participants noted the absence of a follow-up plan integrated into their practice, which could lead to some patients being missed.

> *I would say that I feel like we're missing a lot of families who would want to go forward because of the stage that it's being introduced. It's being introduced, for most patients, at a really information heavy stage. – ID5, Genetic Counsellor*

> *I think there's just a lot of information that [patients] take in at once. – ID14, Physician*

However, some participants expressed that for patients using donors, it can be too early to understand the relevance of ECS if they have not viewed donor profiles yet, but if too late, patients have expressed frustrations.

> *On the flipside, I have some patients who [are referred to genetic counselling] … at a point where patients haven't even looked at donor profiles and they can't even appreciate the benefits of the carrier screening. There's this fine line between it being too early and the patient doesn't really grasp the potential benefits of it. So, they're getting referred too late, and the patients like 'great, now I've got one more thing to delay me, and I was hoping next cycle to do my insemination'– ID16, Genetic Counsellor*

In summary, inconsistent clinic workflow and limited guidance about best practices were cited as a barrier to implementing ECS into routine practice within all fertility clinics. A key challenge is the lack of a best practice standardized model describing how to offer and deliver ECS to patients. This has left participants feeling unsupported in being able to provide ECS care effectively to fertility patients and concerned about service gaps.

"In Canada, people are not accustomed to paying for healthcare": ECS is an Added Expense

Some participants brought up costs as a limiting factor to implementing ECS. Beyond just the cost of the test, costs for genetic counselling services, clinic fees and downstream costs of PGT were mentioned.

> *The cost of the test, and the time required to introduce it, discuss it, explain it to the couple. Cost and time. – ID15, Physician*

One physician, without an in-house genetic counsellor, expressed that incorporating a genetic counsellor into their practice means increasing fees for their patients. Further, they felt that patients would be less inclined to pay an additional fee for genetic counselling after already paying for the cost of ECS unless it can be packaged together, as genetic counselling services are not billable to provincial health.

> *Certainly, I think there's a huge role for genetic counsellors…. [and] most clinics have genetic counsellors on staff, but I think that it would be difficult if that comes at a cost to patients. So, unless it was somehow compensated by the carrier screening companies, I just think that it would be difficult to have patients pay for the test and then also defer any counselling around results to a cost for a genetic counsellor– ID13, Physician*

Several participants mentioned that the test cost makes them less inclined to discuss ECS with their patients. They feel that ECS is not accessible to all patients due to the additional cost. Further, clinics need to consider what price to offer the test at to include compensation for services the test requires, such as in-house blood draws, shipping, and paying their staff.

> *I guess for the price I feel it is expensive because we have a margin made that benefits the clinic… I would definitely like if the test were more accessible... the fees are high, I feel. – ID2, Genetic Counsellor*

> *I think the only barrier would be cost for a patient. There's no barrier really to me ordering it or anything. It is an expense for people though, right, it's about three hundred dollars now. – ID14, Physician*

Further, some participants felt patients would be less inclined to pursue ECS if the test is not something covered or offered within the provincial healthcare system. Within the Canadian healthcare system, patients are not accustomed to paying for any healthcare costs, regardless of the price, which participants felt may make patients reluctant to consider ECS.

> *I think in Canada people are not so accustomed to paying for healthcare in general right? Whether it costs $70 or $700, I think there's always going to be some people where that's going to be an obstacle for them. That they're not going to want to pay, or they can't pay, right? – ID15, Physician*

Participants talked about struggling with the dissonance between offering large ECS panels in the fertility setting when there is such limited funding and strict criteria for accessing funded carrier screening within the public system. Some participants reflected on the cost in the public health care system to employ a genetic counsellor, and how limited provincial healthcare funding towards genetic counsellors is a challenge.

> *To say that I can't even get CF screening for every patient and then saying that we're offering like 300 genes, it's really discrepant. That can be challenging at times. I always struggle with what's available through the [Provincial Health] system, isn't maybe matching what we're offering. – ID4, Genetic Counsellor*

Overall, numerous issues related to the cost of genetic counsellors and the test itself, and how this intersects with what is covered in the public health system were described by participants. Finally, as genetic counselling services are not billable to provincial health, clinics are challenged with finding a way to cover the costs themselves, which may be passed on to the patient.

Participants in the study recognized the complementary skillsets of physicians and genetic counsellors, which could be utilized to productively offer ECS in fertility clinics. However, there is limited access to genetic counsellors and reluctance to rely on outside genetic counselling services. Participants acknowledged ECS for its value and were aware of its

challenges in practice. However, it is not considered a top priority for FHP whose focus is achieving successful pregnancies. Barriers frequently mentioned to implementing ECS included inconsistent clinic workflow, limited guidance, and the lack of standardization for offering and delivering ECS. Participants expressed concerns about feeling unsupported in providing effective ECS care to fertility patients and noted the potential service gaps. The cost of having an in-house genetic counsellor, the test itself, and the lack of coverage in the public health system were also identified as significant issues. Fertility clinics face the challenge of finding ways to cover these costs without potentially passing them on to patients.

4.2.3 Category Three: Fertility Provider Culture Shapes ECS Practices

The analysis of interviews revealed an overarching category: the culture of working in the fertility setting influences FHP views and their approach to implementing ECS in their practices. FHP were found to be influenced by various clinic priorities and unique factors specific to fertility care. While most participants believed ECS should be offered to all patients, there were notable differences between genetic counsellors and physicians in their opinions on ECS. Additionally, many participants expressed strong values regarding informed decision-making, emphasizing its importance in fertility clinics and their impact on ECS practices.

FHP Views on ECS are Influenced by the Culture within Fertility Clinics

The majority of participants stated that in an ideal world, ECS should be offered and discussed with all patients.

> *I think it should be offered to everybody in a very systematic fashion, so that means we have a system. You do the test. You see the genetic counsellor. You have the recommendation. – ID12, Physician*

One participant, however, did not agree with the idea of universally offering ECS:

> *I think it's an overkill, quite honestly. I think it's going to lead to more questions than answers. – ID14, Physician*

While participants agreed on offering ECS universally, analysis identified some key differences when considering the clinical value between the genetic counsellor and physician participants. The physician participants discussed how their opinions on the value of ECS guided the implementation of it in their clinic.

> *It's rare that you're going to be carriers of the same thing. I'm probably going to do literally a thousand tests, or a thousand couples, before I find a couple that has the same condition to avoid that one kid with a metabolic disorder. And even then, they've only got a one in four chance that their kid's going to have it. – ID14, Physician*

> *Honestly, the statistics are what, like 1 or 2% of couples will be carriers for the same thing? So yeah, in my series of a couple hundred…There's just not that many. To be honest with you, I'm not even sure I can think of one couple where we've picked something up on both partners that makes a difference. I mean, I know it will, but it's just not that common. –ID6, Physician*

Most physicians stated they perceived the likelihood of identifying a carrier couple to be low, often referring to this reason as to why they see less utility in the test.

> *I think that unless there is something that we're really looking for, based on family history or concern, which typically really would have been identified prior to seeing us, I don't think there's a lot of utility in terms of absolute risk of us finding something that they're both carriers for. – ID13, Physician*

Additionally, the majority of participants felt ECS was not a top concern and had more pressing clinic priorities. Participants expressed that achieving a successful pregnancy took precedence, and ECS was not a part of achieving this unless the patient was using donor gametes.

> *I mean, these are all very valid things. But they have to be balanced against all of the other aspects of care that [the clinic] is offering. I think in the current system, it's unrealistic to think we can offer this to everybody. – ID15, Physician*

All physicians and genetic counsellors conveyed a donor-centric viewpoint when discussing ECS, often referring to or using examples of patients using donors when discussing their current practices or opinions on ECS.

> *I think it's important to inform [patients using donor gametes] that the testing is available because they will go online, they will find the donors and the donors will have had carrier screening. – ID14, Physician*

> *In my opinion, [ECS] should be more integrated. It's not yet something that is really used routinely. The [Physicians] know about the test… But so far, we don't have a lot of couples doing expanded carrier screening. What we do the most is for the genetic flags for gamete donors. – ID2, Genetic Counsellor*

Overall, the majority of physicians valued the clinical utility of ECS in the donor context, which often influenced how they integrated ECS into their practice.

> *I think giving it to certain populations, like the people who are going to choose donor sperm or donor egg, I think those are the ones that we need to make sure get the information, and the rest of them, it's available if they want it, but is it needed? Probably not. – ID14, Physician*

In contrast, genetic counsellors were more attentive to the risks of finding a carrier couple and expressed a greater appreciation in the value of ECS compared to physicians.

> *It's probably few and far between for those individuals who end up having a child with a condition. But you know, in hindsight, for that one couple, if they could have prevented it. Or at least had the option? I don't know….. the risk of having a child with Down Syndrome is higher, yes, than CF or SMA, but I would still say those two are also reasonably high-risk conditions for just the general public, right? –ID16, Genetic Counsellor*

When considering the culture of working in the fertility setting, analysis of interviews revealed noteworthy differences between genetic counsellors and physicians concerning the clinical value of ECS. While most participants advocated for offering ECS to all patients, over half of physicians disagreed, perceiving the risks of carrier couples as low and questioning the test's utility beyond patients' using donors. Overall, most genetic counsellors had a more significant appreciation for the value of ECS for general population screening, whereas physicians tended to emphasize its utility for patients using donors.

Perspectives on Implementing ECS are Impacted by Liability, Patient Autonomy, and Inequity Concerns

Participants in this study acknowledged that fertility clinics are still a business and have additional factors to consider that differ from providers working in the public healthcare setting. Around half of participants believed that ECS should be offered to all patients as a liability measure. They emphasized that patients investing in fertility care should be informed about the risks of having a child with a genetic condition.

> *From a liability perspective, absolutely, I would be offering all patients carrier screening. The pragmatic side of me says you know, if you're going to be spending all of this money to have a child, you should at least be a little more aware of the risks. And be offered certain options that are out there, right? – ID16, Genetic Counsellor*

Others echoed this sentiment, emphasizing the responsibility of fertility clinics to ensure patients are aware of ECS and its potential implications, especially in ART cases.

> *In my mind, when a child is born with a genetic condition, it's sad news. But when we did something medical to help the couple to have that child, and nobody discussed the risk beforehand, and it could be avoided because we could have asked the question or we could have tested for that; it has an implication, because it's ART. We're helping the couple to get pregnant. So, in my mind, it's an action that we put, so we probably need to be more cautious. Like I said, we could never guarantee that a child will be healthy, that's life, but at least if it's something that afterwards we say, 'we could have avoided because we could have known it, it has implications – ID11, Physician*

On the other hand, some physicians felt less concerned about the liability risks and saw a lower chance of finding carriers in fertility patients, which led them to question the necessity of offering ECS to all couples.

> *I still feel if you have a couple who are planning to use each other's gametes, unless one of them has clearly got something, then I don't really see a reason to screen them, because what are the chances I'm going to find what they have? I think I'd have to screen an awful lot of them before I find the one couple where I would recommend that you don't use each other's gametes. – ID14, Physician*

In response to being asked their thoughts on a hypothetical scenario where a fertility patient had a child born with a genetic condition who asked why they were not made aware of ECS beforehand, one participant emphasize the need to balance resources and risks as a business, suggesting that medical decisions, including offering ECS, require careful deliberation and consideration of associated costs.

> *I think of any of these situations with the lens of hindsight. And especially the patient going through something that's devastating. I mean of course you would like to do anything you can. I think, like anything in medicine, we always just have to weigh the resources versus the risk of that happening. – ID15, Physician*

Additionally, some genetic counsellors described feeling torn between what is offered in the public health system and what they can provide to patients in private fertility care.

> *In the public system, that would never be. [ECS] would never be a conversation you had because you would never waste resources to do that type of testing. – ID9, Genetic Counsellor*

Interestingly, one genetic counsellor challenged the inequity debate centred around private versus public care by comparing the cost of carrier screening to having an affected child with a genetic condition:

> *Some people say 'is this inequity in access to care? And the privatisation of a public healthcare system?' I don't think so. These people would have come to attention at some*

> *point, somehow, and it would have been more expensive to just wait and have them be affected by the disorder. – ID5, Genetic Counsellor*

Two genetic counsellor participants felt conflicted between their obligations to the fertility clinic and genetic counselling values that centre around informed patient decision-making. As a result, they felt they were acting as gatekeepers by not informing all their patients about the option of ECS.

> *What's hard is once something is out there, are we the gatekeepers? It's hard not to offer it to someone if it's available. And we know that and we're all about informed patient decision-making, so it feels like we should let them know that these very large tests are out there. – ID4, Genetic Counsellor*

However, this stance was less reciprocated by physician participants, with some feeling that fertility patients are being given extra information that non-fertility patients would not have access to.

> *It's kind of weird when you think about it. That this is added information that the general population doesn't have prior to getting pregnant with their partner. – ID14, Physician*

In summary, participants shed light on the differences between the public healthcare systems and working in private fertility practice. Some participants argued that incorporating expanded ECS into fertility care was essential from a liability standpoint, as patients investing significant resources in achieving pregnancy should be informed about the risks of genetic conditions. However, physician participants expressed a less concerned viewpoint, and highlighted the importance of navigating the balance between resources and risks in decision-making in a private practice. Genetic counsellors saw ECS as essential information to share with patients and shared challenges of managing informed patient decision-making. The diverging perspectives highlighted the intricacies and influencing factors surrounding the incorporation of ECS in private fertility care.

"At least that they have the information, and they have the power to decide if they're worried or not": *Advocating for Equal Access to ECS for Fertility Patients*

Many participants acknowledged the importance of consistently making all patients aware of the option of ECS while recognizing that the decision to pursue testing should ultimately rest with the patients themselves. Several participants emphasized this in the context

of informed decision-making and advocated for improved access to information about the option of ECS for all patients.

> *I think I think it should be across the board. Everyone should be offered [ECS] but fully understand what it is. If you're offering it to one couple, I think everyone should be given the same options. – ID9, Genetic Counsellor*

> *I think that, yes, expanded carrier testing could be extended to every couple, at least in the fertility clinic. For that reason, at least offer it and if couples say, "No, we're not worried, I'm totally good with that…" But at least that they have the information, and they have the power to decide if they're worried or not – ID11, Physician*

One participant also noted the personalized and subjective way patients see risks and stressed that they should be informed and be able to plan about ECS, regardless of the FHP's personal risk perceptions.

> *I've seen patients with the risk of 25% of having a child with a severe disease, and they say, "Well, 25, that's not that high. If you had said 70-80%, we'd be worried," and I have couples who have a risk of 1 in 1000 of Down syndrome, and they freak out. So, every couple decides which risk they think is high - it's just the fact that we're doing something to help them have a child. At least they should be informed that there's another tool that could maybe reveal something relevant for their child's health. – ID11, Physician*

Conversely, others emphasized the financial, emotional and physical costs endured during fertility treatment as a reason for patients to be provided with the same options and information about ECS.

> *In an ideal situation, it should be [offered] because it's available. And it would just be really unfortunate for them to go through all of this effort to grow their family and end up with a child that has a significant disorder that they wish they could have prevented. To only offer it to people using a donor or something like that just feels unfair at this point. – ID4, Genetic Counsellor*

> *There are other things we can screen for pre-conceptionally to at least give people choices… They may choose not to, and that's perfectly fine. But at least people should be given the option the same way they're given the option to say yes or no to Down syndrome screening, right? – ID16, Genetic Counsellor*

Several genetic counsellor participants voiced concerns about inequity in the current donor-centric approach, where only a subset of patients are receiving information on ECS.

> *I think even though it is a self-pay test – and so there is a health equity issue in having self-pay tests on offer – it is a fertility clinic, and there's a lot of self-pay stuff happening.*

> *And I think it would be a much bigger issue if it were only offered to a subset. Because who is making that call? Why are some people not deserving of having the information about a test that is available to them, right? It's up to each family whether it interests them or not, or they desire the information or not, but who makes the call of who should hear about it? – ID5, Genetic Counsellor*

Many participants felt the cost of ECS was relatively affordable compared to the high expenses associated with fertility treatments, further supporting the idea of offering ECS to all patients seeking fertility care. Further, the comparison of fertility treatment costs to the cost of the ECS test influenced how some participants viewed the test.

> *You know IVF is not cheap. We're talking, you know, twenty, thirty, forty thousand dollars down the road. And so, what's really an extra five hundred dollars to do this testing? – ID9, Genetic Counsellor*

> *[ECS] is not cheap, but it's cheaper than eggs. So, when they are willing to pay $20,000 for a bunch of eggs, it's another few hundred dollars… I've never heard or really rarely heard that a couple are not doing [ECS] just because of cost. I think that when they are in fertility anyway, it costs a lot. – ID11, Physician*

Overall, several participants highlighted the importance of patient autonomy, informed decision-making, and equitable access to ECS information in the context of fertility treatment. Many believed all patients should have access to ECS information and be empowered to decide if they want to undergo testing. Participants emphasized fertility treatment's emotional, financial, and physical costs and argued that offering ECS to all patients was a fair and necessary approach.

Fertility Patients Influence FHP Culture

Participants discussed various aspects of fertility patients regarding ECS. Participants were asked to reflect on whether they had experienced any trends or types of patients choosing to have ECS testing. Participants noted that individuals and couples using gamete donors, those with difficulty selecting a donor, or those from the 2SLGBTQI+ community were more inclined to pursue ECS.

> *I think patients who choose to do it tend to be patients who've had a really hard time picking a donor because they're all carriers and they all sort of question well "do I need to be worried about this?" – ID16, Genetic Counsellor*

> *We have just a lot of LGBT couples who end up doing it, right? Because they're choosing a gamete donor – ID5, Genetic Counsellor*

In addition to those using donor gametes, participants described patients who were adopted, had limited family history information, were information seekers, or were already undergoing IVF with PGT were more likely to opt for ECS.

> *It's usually the people who are information seekers… is usually what I'm seeing. Or people who have limited information about their own family history. People who are adopted or don't know one of their biological parents tend to seem to seek that more often. – ID4, Genetic Counsellor*

> *My younger PGT crowd tend to want to go forward with it. Which is not terribly surprising because they're already seeking out additional information – ID5, Genetic Counsellor*

> *For heterosexual couples, we have seen a few who are really worried or that they were adopted, they didn't know their family history and they worry. So sometimes in that context we can discuss the benefit and the risk of doing expanded carrier screening – ID11, Physician*

However, some participants also brought up that ECS was also seen as a source of increased anxiety and stress for some patients.

> *I think there's anxiety on both sides: I think there's anxiety in the people who are without testing. If you choose a donor and you don't test, then there's going to be anxiety about, "well, what if I am that 1 in 70 person who is a carrier of that condition?" – ID14, Physician*

> *But there's also information that patients otherwise wouldn't have known. There's stress around it in an already anxiety-provoking area. – ID13, Physician*

Another participant mentioned how ECS may be overwhelming for fertility patients, and that it could be seen as a barrier to having a baby.

> *I think it's because people are seeing it as "what if this is another barrier to having a baby? I'm already struggling to get pregnant and to grow my family. And now you're telling me there may be something else that could happen?" And I think it's too overwhelming for a lot of people. – ID4, Genetic Counsellor*

On the other hand, over half of participants noted that ECS often provided reassurance to patients, helping them make more informed decisions.

> *Are patients anxious? I mean not that I've seen. I think from what I see they seem to understand that this is something rare. That it would take two copies, and the chances of that are very low. And so, this is sort of a precautionary step. – ID15, Physician*

> *It's reassurance, a lot of the time, for sure. The clients that I tell them that they're a carrier, or a donor is a carrier for something, I would say ninety five percent of the time, maybe even greater they're like, "well, let's do the testing," like there's no questions really asked. – ID9, Genetic Counsellor*

One participant echoed the reassurance piece other participants cited, and stated some fertility patients were surprised when they received negative ECS results, as positive news in this context is relatively rare.

> *Relief. And usually, surprised. I think usually people going through fertility treatments are used to things going wrong. I think they're almost expecting that something will come up. – ID4, Genetic Counsellor*

Several participants noted experiences and factors that make fertility patients unique from patients in other realms of healthcare. For instance, two participants especially noted ECS created increased stress due to the time-constraints of selecting a donor and receiving their results in time.

> *The problem they run into though, is that they go to all the effort of choosing a donor, and this donor is absolutely perfect; it's the right person for them… and then they need to do carrier screening. By the time the carrier screening results come back, that donor is gone. Because the donors, they sell out all the time. – ID14, Physician*

> *I would say the bigger stress for people – because most of the time they're not that concerned if they're a carrier for something – more of the stress is trying to decide whether to pay for it and then the stress of getting results in time, not knowing if they can pick a donor, and sort of the stress around navigating the whole process of it. – ID13, Physician*

Other participants shed light on how the type of fertility treatments received plays a role in how patients perceive ECS. For some patients already pursuing IVF, the additional information from ECS may be used to consider adding the option of PGT-M to their treatment. For other patients, they may already be going through other complex treatments and thinking about ECS can be overwhelming for them.

> *I guess one of the determinants is IVF. Because if we do identify something, we could test the embryos… Some people just want to control the risk at the maximum and say, "okay we are in the medical process, because we are in the fertility clinic, so we're going to confirm everything." And some people are like, "Oh there is already so much medical"*

and they want to make it more natural as possible. I think it's also a matter of personal feelings. – ID2, Genetic Counsellor

Two participants noted they are more likely to bring up ECS with patients who are already proceeding with PGT for another reason, as they would already be testing the embryos.

The other part of my case load is patients who want to do PGT-M or PGT-SR. When I'm discussing those tests with them, I say," well, since we're already testing the embryos, you know, it's not an extra cost to add an extra gene." – ID9, Genetic Counsellor

I haven't necessarily noticed a treatment-based trend in that. Sometimes we always wonder about people doing PGT-M. I offer it in case there's a second genetic condition that comes up, and I haven't even found an incredibly high uptake with that population either. – ID4, Genetic Counsellor

Further, a few participants emphasized the unique characteristics of fertility patients, such as their desire for control in the process and their familiarity with making decisions and accessing extensive information.

If I have a 30-year-old who's coming to talk about pre-implantation genetic testing with me, they are already accessing kind of a higher degree of genetic testing than is maybe average for their group. – ID5, Genetic Counsellor

Clients at fertility clinics are very different than any other type of genetic counselling I have ever done. They want to have the baby they want; they feel like they have a little bit more control over the child that that they have. And so most times they want this information. – ID9, Genetic Counsellor

Conversely, about half of participants commented that limited awareness of ECS among patients was a common issue, possibly due to the overwhelming amount of information provided in fertility clinics or a lack of general public awareness. Some patients also had misconceptions about ECS, emphasizing the importance of patient education in this area.

There's also a subset of patients that pick a donor and never even pay attention to carrier status. Because I've seen these patients down the road for other reasons, and then you'll go back and be like "well do you have the donor profile? Do you know if they were a carrier for anything?"[and the patient says] "Oh, I don't think they were." And then you look, and they absolutely were, and they just completely missed that information…. But you wonder if patients get too inundated, maybe they miss the point of doing it? It's just one more pamphlet to read that maybe they don't. – ID16, Genetic Counsellor

I've had people who were actually surprised that they're donor is a carrier for something… we send [patients] this communication of risk form saying, "Well, your donor is a carrier of X, Y, Z, and here are the carrier frequencies and here is the risk."

> *And they inevitably write back to me and say, "I didn't realise that." I'm like, "You signed the paper!"– ID14, Physician*

> *I think the biggest sort of misinformation is that patients will say, "well, I don't know about anything in my family. So why do I need to test?" And I say, "that's exactly why, because most of the people who have diseases in their family don't know about them – ID6, Physician*

In summary, participants highlighted that patients who are "information seekers", those using gamete donors, or those already doing IVF with PGT were more inclined towards ECS. Some participants felt ECS was a source of anxiety for some patients, while others thought it provided reassurance. Participants described fertility patients as having a desire for more control and were used to accessing information, but their awareness of ECS was often limited.

In conclusion, the analysis of interviews to recognize the culture in the fertility setting revealed some key differences between the opinions of genetic counsellors and physicians regarding the clinical value of ECS. While most participants agreed that ECS should be offered to all patients in an ideal world, some physicians expressed reservations about its universal implementation, citing low likelihood and the prioritization of other clinic concerns. Some participants emphasized the importance of informed decision-making and advocated for equal access to ECS for all patients. In contrast, others mentioned the essential need to balance the business and liability aspects of operating a fertility clinic. Many participants believed patients should be aware of all available options, regardless of their perceived risks, and should be empowered to make their own choices about ECS. Participants viewed ECS from a donor-centric mentality, which some felt was limiting fair ECS information distribution to non-donor patients. Additionally, comparing ECS costs to fertility treatment expenses further supported the argument for offering ECS to all patients. Lastly, participants described their experiences with fertility patients, highlighted the uniqueness of this patient population, and discussed this influence on their ECS practices. Overall, the interviews shed light on how the culture of FHP plays a large role in the complexities surrounding ECS implementation in the private fertility setting.

4.2.4 Category Four: Participant-Driven Changes and Recommendations: Enhancing ECS Delivery

Participants delivered various recommendations and changes they felt could help mitigate some of the barriers and challenges discussed (Table 5). These included changes to how and when ECS information is provided to fertility patients, recommendations to improve genetic counselling access, and the need for physician support to implement changes to improve ECS care.

Table 5. Changes and recommendations to improve the integration of ECS in fertility clinics

Recommendation	*Description*	*Examples*
RECOMMENDATION #1 *"ECS should be included as a part of any welcome package":* Improving the way ECS is offered	The concept of ECS should be introduced ideally during the initial fertility consultation and further information that is accessible and comprehensible be available at various points during a patient's journey.	▪ Using videos, pamphlets, and/or including information in patients' welcome package ▪ Automated follow-up (email, patient portal) sent to patients ▪ Including ECS information in more places such as in the waiting room and on the clinic website ▪ Educational materials in multiple languages
RECOMMENDATION #2 *"I don't think you need a genetic counsellor to order carrier screening":* Novel approaches to pre-test counselling	To increase capacity, utilize alternative pre-test counselling approaches that do not require a genetic counsellor or reduce genetic counsellor involvement.	▪ Virtual group counselling sessions ▪ Online interactive modules or videos ▪ Training of non-genetic healthcare professionals to provide pre-test counselling and informed consent

		▪ Have a genetic counsellor available if patients have further questions
RECOMMENDATION #3 *Call for increased supports among ECS laboratories*	ECS laboratories could support clinics by enhancing access to genetic counselling and providing educational materials to support patients and professionals.	▪ Improving the clarity of test reports ▪ Increase awareness on external genetic counsellor services available and how to access ▪ Automatic genetic counselling appointments ▪ Pre-made educational materials tailored to both patients and physicians
RECOMMENDATION #4 *The public health system should offer ECS wherever pre-conception counselling is done*	ECS should be included as an essential aspect of pre-conception counselling for all individuals, making it more widely accessible beyond fertility clinics.	ECS adopted by primary care/family physicians' and OBGYNs' as part of standard care
RECOMMENDATION #5 *"It's really a matter of the doctors thinking that it's a good test": The involvement of physicians is necessary to offer ECS and support genetic counsellor involvement*	Increased support for offering ECS among physicians and clinic leaders, including the engagement of genetic counsellors in the planning and implementation of processes	▪ Workflow for physicians to consistently introduce the topic of ECS during the initial consultation and refer patients to genetic counsellors if needed ▪ Genetic counsellors provide education to physicians and clinic leaders about the clinical value and outcomes of ECS ▪ Opportunity for genetic counsellors to suggest changes to workflow and processes to clinic leaders

Recommendation #1: Information about "ECS should be included as a part of any welcome package": Improving the way ECS is offered

Most participants agreed that ECS information should ideally be offered pre-conceptionally, during their initial fertility consult, and always before a patient decides to do IVF. Aligned with the above recommendations, many participants stated the information provided around their initial consult could come in various formats, such as pamphlets, videos, or welcome packages.

> *I think [ECS information] should be included as part of any welcome package. – ID6, Physician*

> *We ideally do it before pregnancy… [with] maybe some sort of video or pamphlet, and then if patients have further questions they can ask. – ID16, Genetic Counsellor*

Though the majority agreed that it was ideal to provide ECS information early on in a fertility patient's journey, it is not without its challenges that many felt needed improvement. As discussed in category two: "Barriers and challenges", participants initially brought up concerns of information overload when introducing the concept of ECS to patients. A few participants recommended tackling these concerns by incorporating more checks-in, having a follow-up plan, or creating yearly reminders.

> *I think that if we had a larger genetics team, there could maybe be more check-in points. – ID4, Genetic Counsellor*

> *It's really hard to navigate where that's going to fit in… We're thinking about ways of how in every meeting the physicians sort of check in [asking patients] "have you read our lifestyle handout about folic acid," or whatever it is? To have a second check-in [asking] "have you read your expanded carrier screening or your genetics information sheets? Do you have any questions? Do you want to talk any further with a genetic counsellor about that?" – ID5, Genetic Counsellor*

> *If there are patients at the clinic for years, you know, maybe like a yearly reminder or something they can access. – ID4, Genetic Counsellor*

One participant mentioned they have thought about addressing this issue by trying to trickle-feed information to help avoid the information overload issue.

> *One of the things we've been thinking about as a clinic is how can we trickle feed the information to a patient over those first couple of months. They get month 1: the pre-*

> *conception lifestyle; and a couple of handouts every week to read over in month 1. And then month 2 is medical preparations for fertility, and you have information about genetic testing or things like that. – ID5, Genetic Counsellor*

Similarly, to provide small doses of information, one participant discussed how they had made modifications by increasing the number of places they have ECS information available to patients. This has helped in patient awareness by not limiting access to ECS information at the start of their fertility treatment.

> *I think what we're doing right now is working well. I think patients are aware it's available. We have it on our website; we have it on our pamphlets; we have it kind of all over the place. I think there's just a lot of information that they take in at once. And so that's why we have it in multiple places. – ID14, Physician*

Other suggestions included having an information package and integrating ECS into the clinic with "*something that is a bit more built-in, rather than a patient opt-in the system would be beneficial" (ID5, Genetic Counsellor).*

> *Maybe they're given some sort of info package about the pros and cons of carrier screening. And if they have more questions after reading it, then they get an appointment. – ID16, Genetic Counsellor*

One participant highlighted the need for developing ECS information in more languages to expand patient access. As mentioned in the "Barriers and Challenges" category, this goes hand in hand with responses from a different participant who had also brought up language as a barrier to utilizing ECS laboratory's genetic counselling services, highlighting the overall need to improve this aspect of providing ECS.

> *I think there is one roadblock, which is about health literacy and people who do not have English as a first language. I really need to work on figuring out a better way of providing information sheets. Because how do patients who do not have a great understanding of the English language still access that information? – ID5, Genetic Counsellor*

To summarize, participants agreed that ECS information should be offered pre-conceptionally, ideally during the initial fertility consultation or as part of a welcome package. Participants highlighted the importance of making ECS information available at various points during a patient's journey and ensuring that it is accessible and comprehensible to all.

Recommendation #2: "I don't think you need a genetic counsellor to order carrier screening": Novel Approaches to Pre-test Counselling

Participants discussed ways to improve methods of providing patients with information on ECS and alternatives to pre-test counselling that do not involve a genetic counsellor. Many felt that the pre-test was where they needed to make the most improvements.

> *That's what we need to work on. Is that pre-test? Even if it is an information sheet or something that's given to each patient. – ID9, Genetic Counsellor*

The majority said they did not think a genetic counsellor was necessary for ECS pre-test counselling and would be comfortable with alternatives. Some felt that other staff members, such as nurses, genetics assistants, and physicians, could provide basic pre-test counselling on ECS for the patient to be able to make an informed decision.

> *I don't necessarily think you need -- a lot of genetic counsellors would hate me for saying this, but I don't think you need a genetic counsellor to order carrier screening. I think a physician can order it as long as they're educated and well-informed to consent to it appropriately. – ID16, Genetic Counsellor*

> *I don't think individual counselling is really necessary for expanding carrier screening. I think that the availability of it is important, but I think that most clients don't need it. – ID9, Genetic Counsellor*

In response to being asked who else they thought could have conversations about ECS with patients, participants answered:

> *I think our nurses…I don't know if they could counsel so much about genetic risks, residual risks, but I think they can at least counsel what genetic carrier screening is. I think they'd be able to do that. – ID14, Physician*

> *A genetic counselling assistant, who would be available to answer questions [on ECS]. Or you know we have, as I am sure most fertility clinics, crazy wait times in the mornings to see the physicians, and so maybe we did like a video that's on the TV in the waiting room where people can just watch it, or something like that. – ID9, Genetic Counsellor*

While recognizing the importance of genetic counsellors in various settings within a fertility clinic, one participant pointed out that mandating a genetic counsellor for pre-test counselling could create an additional barrier to accessing ECS.

> *I think that a genetic counsellor is very important when there are complicated cases. I mean, understanding mosaics is one thing. Explaining the probabilities of PGT-M is another. But if they're considering having this test. I don't know. I think that that's a bit of*

> *a barrier if they have to go see a genetics counsellor before they can do the test. – ID6, Physician*

Several participants felt that an online option for pre-test counselling would be ideal and that patients may prefer this option. Some ideas mentioned were online modules, an online resource patients can refer to, email attachments, and videos.

> *Practical world, I think having some really good online modules is way more efficient and better use of everyone's time. A patient gets to read and provide their informed consent. And testing gets ordered. – ID5, Genetic Counsellor*

> *A set of online resources that patients can read about to help them decide if they want to do the testing and basics of how to read their own reports. Or something that is digital that can be attached to an email sent out to a patient. – ID13, Physician*

> *Well, I think the best way is…videos or online interactive modules. The people prefer [online options], and they can do it when they have time. And maybe after that, they can get an email or something saying, 'Do you have any kinds of questions?' – ID12, Physician*

Another novel approach one clinic has already began successfully applying, are virtual group sessions run by their in-house genetic counsellor:

> *I'm all about virtual group sessions. It's a really good way to get the education piece, and then you can have much shorter consenting sessions if needed….. I think that it's really improved things for us because more patients are able to access it because of the group format and because it's earlier in their process. – ID4, Genetic Counsellor*

While many agreed that ECS pre-test alternatives were a good idea, some cited caveats to this, stating a genetic counsellor's involvement would still be needed, particularly when handling ECS results.

> *I just think sometimes, for downstream results, you would need a genetic counsellor's involvement. – ID16, Genetic Counsellor*

> *Do I think that somebody other than a genetic counsellor could counsel somebody on expanded carrier screening? Yeah. I mean, certainly before the results or before the test is done. I mean, interpreting the test is a different matter. – ID6, Physician*

Participants explored various methods to improve the provision of ECS information to patients, predominantly focusing on alternatives to pre-test counselling and improving patient access to ECS information. There was a consensus among participants that a genetic counsellor may not always be necessary for ECS pre-test counselling, and other healthcare professionals

like nurses, genetic counselling assistants, and physicians could provide basic counselling if they were educated and capable of obtaining informed consent. However, it was emphasized that the involvement of a genetic counsellor would still be necessary at times, particularly when interpreting ECS results.

Recommendation #3: Call for Increased Supports from the ECS Laboratories

Some participants proposed strategies for ECS laboratories to act as a resource and enhance access to reliable genetic counselling services. They recommended various approaches, including implementing an automatic system for scheduling genetic counselling appointments, demonstrating to providers the reliability and trustworthiness of the available genetic counselling services, and offering resources that can be utilized in clinics to support FHP.

> *I mean, the more the [ECS] company will do... The better, right? I think if I knew as a doctor that the patient was going to be well-taken care of and well counselled, and they would easily be able to get hold of a genetic counsellor with the company, then I'd feel a lot more comfortable making it part of sort of the introductory package. – ID15, Physician*

> *I think about the clinics who don't have an embedded genetic counsellor…And I wonder …is there a way that a clinic can have an automatic system? Where automatically that patient then gets paired and setup for an appointment with the [ECS] lab's in-house counsellors? - ID5, Genetic Counsellor*

Beyond providing genetic counselling services, a few others mentioned additional ways the ECS laboratories could help support fertility clinics. One participant felt they could provide more information in their reports to make results disclosure easier, especially if there are health implications associated with a carrier result.

> *I think that other labs making their reports less burdensome on the care providers may be quite helpful because sometimes there's information that the lab genetic counsellors are aware of if you call them, but maybe that info wasn't on the report. Sometimes it can be helpful to have all the details about a specific variant and information about patients at risk of developing symptoms because they're a carrier. If that's clear on the report, that's really helpful, so that we're not having to do a ton of work after receiving it. I think that as much as the lab can do to make the disclosure part easier for the clinicians is helpful. – ID4, Genetic Counsellor*

However, one participant emphasized that clinics needed to take proactive steps to improve access instead of having the genetic testing laboratories drive the change.

> *I don't think the companies can really do something specific to access those patients. It's more like the clinic that needs to organize better for that. -ID2, Genetic Counsellor*

Overall, participants suggested that ECS laboratories could serve as a valuable resource by enhancing their genetic counselling services and providing educational materials to support patients and professionals, which could increase the FHP confidence in incorporating ECS into their practice. However, not all participants believed that ECS laboratories alone could address the issue of patient access.

Recommendation #4: The public health system should offer ECS wherever pre-conception counselling is done

Many participants emphasized the need to enhance ECS access through the public health system by integrating it into primary care/family physicians' and Obstetricians and Gynecologists'(OBGYN) practice. They argued that discussions on ECS should be incorporated as a standard part of pre-conception counselling, stating that any discussion on ECS should be incorporated "*wherever pre-conception counselling is done" (ID6, Physician),* alongside other essential information provided to patients.

> *The majority of babies born in this world are not going through fertility clinics. So, if talking about a broad use of this resource, then it's to take it out of fertility clinics… I think fertility clinics are one place to start, but it's a much bigger question as to where else you would do it. – ID6, Physician*

> *Essentially, it's like all the things that someone needs to go through with their obstetrician, right? Like a roadmap of what their ultrasounds will be, the lifestyle factors, and the genetic testing that's going to happen. All those things that need to get introduced, and how do those pieces get introduced in a standardized way? – ID5, Genetic Counsellor*

Some participants further elaborated on this notion, suggesting that improvements in how carrier screening is offered within the current public health system would pave the way for providing ECS in the private fertility setting.

> *I mean, I think that every person who shows up to their family doctor should get a pamphlet about expanded carrier screening. Along with their folic acid. But I do appreciate that getting screened into primary care is a lot harder. But I think that it would be important that every person actually hears about it. – ID5, Genetic Counsellor*

> *We should be aiming for the other way of making it available to everyone, even outside of the clinics. – ID4, Genetic Counsellor*

One participant emphasized that integrating ECS into primary care would be similar to the transition made from genetics providers to family physicians for ordering hemoglobinopathy screening.

> *I think it should be primary care providers. The same way we do now. [Primary care providers] do screening for hemoglobinopathies, right? – ID16, Genetic Counsellor*

Another participant added that pre-conception counselling should be an expense covered by the provincial healthcare system, which would allow for an allotted appointment space to be able to have conversations about ECS:

> *I think there does need to be some sort of fee code maybe worked into [provincial billing service]. Where they can have like a separate appointment and billing code for pre-conception counselling. – ID15*, Physician

Further, another participant noted the increased need for support and funding from the provincial healthcare system to create better access to genetic counsellors is needed. In the case that ECS stays within the private setting, fertility clinics (including those with in-house GCs) need to be able to refer patients to their provincial genetics program when a patients' needs fall outside the realm of reproductive genetics care.

> *Having the understanding and support of the provincial healthcare system and our provincial counsellors, who are all so great in accepting all of my many referrals that I send their way. Because there are pieces that we can't handle, right? We cannot take over kidney investigations for that patient. We do not have the right team in place to do that. And so that's going to have to end back in provincial healthcare. – ID5, Genetic Counsellor*

In conclusion, participants recommended that improving ECS access should begin by incorporating it into the public health system, standardizing its introduction alongside other crucial elements of pre-conception care, thereby extending its availability beyond fertility clinics.

Recommendation #5: "It's really a matter of the doctors thinking that it's a good test": Physician recognition is necessary to offer ECS and support genetic counsellor involvement

Although participants discussed many valid changes and recommendations to enhance the ECS process, most genetic counsellors expressed that implementing these changes would require the support of physicians at their clinic. They noticed the diverging opinions about the test mentioned in category three and believed that before proposing any changes, it was essential to enhance physicians' understanding and appreciation of the value and clinical utility of ECS.

> *What I need more than anything is buy in from the physicians that this is important and required... I have said before 'maybe we need to look into this more' and [the physicians] were like 'No, we, you know, we think it's fine. We've never had any complaints from patients.' That's how a lot of these things are measured, is has a patient ever complained about it? – ID9, Genetic Counsellor*

Similarly, another genetic counsellor expressed a comparable perspective, mentioning that they had advocated for introducing the topic of ECS with patients to the physicians at their clinic. However, they encountered resistance regarding the idea of not involving a genetic counsellor in pre-test counselling and consenting.

> *I think it's really a matter of the doctors thinking that it's a good test…We did some counselling presentations to the doctors to explain the test, but [the doctors] think that we need the genetic counsellor maybe to present the advantages of the testing. Some patients, they don't want private testing and that's fine, it is expensive. But some patients don't even know that this exists. And we had a case where two couples were identified to have the same gene mutation. So, I think it's pretty clinically relevant. One of them is now doing PGT-M for this condition, so it is something that can really, you know, influence the fertility process. – ID2, Genetic Counsellor*

Genetic counsellors suggested the creation of educational a presentations or information sheets targeted at physicians, which could be supported by the ECS laboratories.

> *I think I need to educate more of the physicians as well about [ECS]...Maybe, if the testing labs provided some type of presentation like that…Or an information sheet for patients. If all that stuff was already available and provided, then that would be so much easier for me to then implement it. – ID9, Genetic Counsellor*

Another genetic counsellor proposed a solution wherein physicians could initiate a brief conversation about ECS with patients during their initial consultations, leveraging the existing trusting relationship between physicians and patients. If the patients show interest, the physicians could then refer them to the clinic's genetic counsellor. However, this approach would require physicians to recognize and appreciate the value of the test to facilitate its implementation.

> *I think it would be simple for every patient to have a five-minute discussion with the doctor about that. And if they're interested, then they're referred to a brochure and a genetic counselling session… It's really up to the doctor to say they think [ECS] is relevant. In my opinion, the patients are really listening to the opinions of the doctors. – ID2, Genetic Counsellor*

Participants recommended various improvements to enhance the ECS process. However, genetic counsellors felt that implementing these changes would require the support and

understanding of the physicians at their clinics and acknowledged the need to improve physicians' comprehension of ECS's clinical value to encourage its adoption.

In summary, participants identified numerous valid recommendations and changes to improve access to ECS within fertility clinics. They suggested alternatives to genetic counsellors for pre-test counselling, such as nurses or online modules, and emphasized the importance of providing comprehensible ECS information early in patients' fertility journey. Participants also highlighted the need for improved language accessibility and the integration of ECS information into clinic resources. Additionally, they discussed ways in which ECS laboratories could support fertility clinics, including offering automatic genetic counselling appointments and improving the clarity of test reports. However, participants recognized that implementing these changes would require the support and involvement of the clinic physicians. Some recommended educating physicians about ECS, while others suggested that ECS should be incorporated into primary care and obstetrician practices to ensure wider accessibility. Overall, the participants acknowledged the challenges but stressed the importance of collaborative efforts to enhance access to ECS.

CHAPTER 5. DISCUSSION

This study is the first to apply qualitative interviews to explore the opinions of Canadian FHP regarding ECS. The study had three primary objectives: understanding ECS integration into clinics, identifying barriers and facilitators, and assessing FHP opinions, including the potential integration of ECS into preconception counselling.

In this study, participants shed light on the current landscape of different fertility clinic practices and policies regarding ECS. Several described that ECS was introduced to patients inconsistently at their clinic and mainly depended on the treating physician's preference. Similar to other studies on the implementation of carrier screening, this study described a lot of variability across clinics in the manner in which ECS is introduced to patients. As previous described by Delatycki et al. (2020) in their review of reproductive carrier screening practices across nine different countries, they reported vast diversity in practice, stating these discrepancies stem from differences in geographical regions, variations in local healthcare, financial resources, cultural beliefs, and religious factors. This study not only extends the findings of Delatycki et al. (2020) but also uncovers novel factors, specifically the perceived value and priority of ECS, contributing to variations in ECS practices across clinics.

5.1 Providers' Personal and Professional Views, Values, and Education Guide ECS Practices

Almost all participants in this study were proponents of ECS in concept. However, the results of this study revealed that REI physicians and genetic counsellors differ in their opinions about the clinical utility, priority and value of ECS. While our participants shared that there are inconsistent ECS practices often due to the treating physician's preference in their clinics, the participating physicians were largely proponents of ECS, with many expressing that, in an ideal world, all patients should be offered ECS. It is not known whether physicians who chose not to participate had similar or differing opinion of ECS.

Similar support for ECS among reproductive physicians was demonstrated in a study conducted by Briggs et al. (2018). Their results revealed that subspecialists were more likely to offer ECS, with REI physicians having the highest likelihood among all subspecialists.

Additionally, Benn et al. (2014) found that more than half of the surveyed obstetricians acknowledged providing ECS when requested by patients, although only 15% were extending ECS to all patients at the time. Paralleling this, participants in this present study mentioned that counselling and educational resources about ECS were available at their clinics but were contingent on patients conducting their own research and requesting ECS. The exception to this, as noted by most participants, was observed in the case of patients utilizing donor gametes, where ECS information was more consistently provided. These variations can be ascribed to the fact that, as some participants pointed out, anonymous donor gametes universally come with carrier screening reports that specify whether the donor is a carrier for a genetic condition. Patients are informed of this information before acquiring the donor sample and are required to sign a form confirming that they have reviewed and comprehend the selected donor's carrier status (Xytex Canada, 2021).

Genetic counsellors in this study gave strong support for ECS, with greater emphasis compared to the physician participants. Although research comparing genetics and REI professionals' opinions is limited, one study has echoed similar perspectives about ECS among these professionals (Ramdaney et al., 2022). This is not surprising, as exploratory studies have demonstrated genetic healthcare providers' support for the integration of ECS into the fertility setting. Clinical geneticists in Europe believed ECS could be routinely offered to all people who use assisted reproduction (Janssens et al., 2017). Similarly, the majority of Canadian genetics providers in a study by Michalski (2022) suggested the discussion of ECS was particularly important in the fertility setting, as the optimal time to offer carrier screening is pre-conception. Furthermore, Lazarin et al. (2016) reported most genetic counsellors (90%) advocated for ECS availability during preconception counselling, and 92% of reproductive genetic counsellors supported the routine implementation of ECS. Additionally, the study by Lazarin et al. (2016) investigating genetic counsellors' personal views on ECS found that that most genetic counsellors preferred to undergo ECS themselves and be screened for a broader range of conditions, signifying their recognition of the value of ECS.

Interestingly, in the Michalski (2022) study, a discrepancy between the professional and personal value of ECS was observed among Canadian genetics providers. The study revealed that genetics providers uniformly expressed a personal inclination towards pursuing ECS or had

privately covered costs for some form of personal genetic testing. However, in their professional practice, they felt obligated to align with Canadian healthcare objectives by prioritizing service for individuals at the highest risk (Michalski, 2022). Similarly, a minority of genetic counsellors participating in this study described a similar prioritization, perceiving they were inadvertently acting as gatekeepers by not consistently informing all their patients about the ECS option. They described these feelings as stemming from conflicts related to the genetic counselling principles, which prioritize informed patient decision-making, with a conflicting obligation to manage healthcare resources.

Hence, the integration of the findings of this study, along with previous research, suggests genetics providers support the integration of ECS in the fertility setting. This support may be a key factor contributing to the varied levels of support observed between physicians and genetic counsellors seen in this study.

5.1.1 Uncommon Does Not Equal Insignificant

The results of this study revealed that physicians and genetic counsellors also differ in their opinions about the clinical utility of ECS. The term "clinical utility" in the context of a genetic test pertains to the practical value of genetic information for medical practice and its potential to substantially enhance patient outcomes (Henneman et al., 2016). In this study, most physicians held the perception that the risks for carrier couples are rare and raised doubts about the broader utility of ECS beyond the donor setting. Previous research conducted has likewise indicated that the perception of ECS and its clinical utility among healthcare providers has been mixed (Ramdaney et al., 2022, Lazarin et al., 2016). For example, in one study, clinical geneticists stressed that ECS might not yield significant medical advantages due to the relatively low occurrence of carrier couples within the general population (Janssens et al., 2017). They further noted that only a small fraction of screened couples would encounter actionable findings (Janssens et al., 2017). While the number of at-risk couples identified through ECS is highly variable and largely depends on the test panel used, past research has illustrated that solely screening based on ethnicity and reported family history will fail to identify most carriers (Kraft et al., 2018; Schuurmans et al., 2019).

The concept that many disorders on carrier screening panels are considered rare, leading to a low likelihood of encountering carrier couples and thereby challenging the effectiveness of

ECS, is an opinion not limited to the participants in this study (Stoll & Resta, 2013). In fact, this very notion forms the foundational basis for traditional ethnicity-based screening guidelines. Still, the term "rare" requires a fresh perspective when considering the rationale for carrier screening. For example, the study by Lazarin et al. (2013) demonstrated that approximately 1 in 400 births in the US are affected by a rare disease encompassed in their research (Stoll & Resta, 2013). In Canada, roughly one out of every twelve people, mostly children, suffer from a rare disorder, with genetic changes accounting for 80% of these conditions (Canadian Organization for Rare Disorders, 2023; Health Canada, 2018). Drawing from Wilson & Jungner's 1968 guidelines for general population screening, it is important to recognize that a disease does not necessarily need a high prevalence to be deemed significant (J. M. G. Wilson & Jungner, 1968). Although individually each disease is rare, when taken together, rare diseases occur frequently enough to impose considerable burdens on public health and patients alike (Canadian Organization for Rare Disorders, 2023; Ferreira & van Karnebeek, 2019).

Additionally, the genetic counsellors in this study conveyed that genetic conditions, such as CF and SMA, are more prevalent than commonly assumed, a perspective also highlighted in the study by Lazarin et al. (2016). Both the United States and Australia have embraced the practice of routinely offering CF and SMA screening, implying that the heightened awareness of the genetic counsellors in this study toward identifying carrier couples is not solely based on personal values but may be more evidence-based. Furthermore, the "too rare" argument is outdated, as recent literature indicates that 4% of couples are carriers for the same condition, a significantly higher figure than the 1-2% quoted by some physicians in this study. Data from one ECS laboratory, based on a 288-gene panel, revealed that approximately 4-8% of couples undergoing comprehensive carrier screening had a 25% risk of having an affected pregnancy. Within this subset, 3.7% were at risk for classically presenting severe conditions (Sroka et al., 2023).

As one participant noted, individuals are made aware of the option to screen for Down syndrome during pregnancy. The prevailing consensus in healthcare is that everyone should have access to information about the availability of this screening for Down syndrome during pregnancy, thereby empowering them to make informed choices. The genetic counsellors in this study do not dispute that the conditions covered in carrier screening are less common than Down

syndrome. However, they contend that dismissing these conditions as "too rare" is not a compelling argument against informing patients about the availability of ECS. Nevertheless, participants in this study advocate for providing patients with comprehensive information on ECS so that patients retain the autonomy to choose whether or not to undergo it based in line with their values and preferences regardless of the rarity of the diseases covered through ECS.

5.1.2 Training Differences between Genetic Counsellors and REI Physicians May Influence Values

The results of this study revealed that physicians and genetic counsellors also differ in their values surrounding offering ECS and patient autonomy as it plays into reproductive choice. Physicians were more likely to consider the entire picture of the broader fertility clinic and generally focused on collective goals of successful pregnancies. On the other hand, genetic counsellors emphasized a patient-centred approach in reproductive decision-making as a primary outcome. These differences may be traced to these participants' distinct training and educational backgrounds. REI physicians possess extensive medical expertise in obstetrics, gynecology, and surgery, plus advanced knowledge of complex reproductive hormone interactions, conception mechanics, and male and female anatomy (Chenette, 2010).

In this study, genetic counsellors demonstrated a heightened sensitivity towards identifying carrier couples and assessing the likelihood of a child conceived through ART being born with a recessive or X-linked genetic condition. While there may be various factors influencing this, one plausible explanation could be their exposure to a broader spectrum of genetic conditions. On the other hand, the majority of REI physicians have less exposure to genetics patients. Their clinical priority is to address issues such as infertility, failed implantations, miscarriages, and pregnancy complications (Chenette, 2010). Consequently, their attention may be less directed towards the genetic risks of having an affected child. Furthermore, the integration of genetics into the field of fertility is relatively recent. Many REI participants completed their residency and fellowship training before this expansion. In this study, half of the participants had over 10 years of experience. To provide a clearer view of the significant changes in the past decade, only 0.5% of treatment cycles in 2013 included PGT, whereas in 2022, this

figure increased substantially to 15.8% (Canadian Fertility and Andrology Society (CFAS), 2023).

Further, while REI physicians frequently navigate facilitating decision-making for their patients regarding fertility treatments, they may have discomfort with discussing genetic testing, as found in the study by Briggs et al. (2018), and as communicated by several of the participating REI physicians in this study. On the contrary, genetic counsellors receive specialized training in patient-centred decision-making in genetic testing, employing non-directive counselling and therapeutic techniques and using impartial language to empower patient autonomy (S. Edwards & Laing, 2022; Godino et al., 2021). While these differing perspectives and practices can be complementary as part of a team, there is the potential for healthcare disparities when a team model is not available. FHP with differing genetics knowledge and backgrounds may approach informed decision-making and the choice of ECS for every patient quite differently, which could be perceived as inequities in service delivery.

In summary, this study delved into the perspectives of physicians and genetic counsellors regarding ECS in the context of fertility healthcare. While most participants supported ECS, differences emerged in their opinions on its clinical utility and value. These distinctions could stem from their different training and educational backgrounds; however, further investigations are required to explore these distinctions and their underlying influences comprehensively.

5.2 Influence of Liability Concerns

The participants in this study highlighted the comprehensive toll of financial, emotional, and physical burdens patients experience throughout infertility treatments. As such, these challenges motivated some participants to ensure that patients have equal access to options and information about ECS. Even further, a subgroup of participants, mainly the genetic counsellors and one physician with a genetics training background, stressed that integrating ECS into fertility care was morally imperative and held significance from a liability perspective. They articulated that subjecting a patient to infertility treatment only to later have their child be diagnosed with a genetic condition that ECS may have identified would be problematic. This concern stemmed from both considerations of accountability and the potential legal ramifications if such a situation were to arise.

Past instances of IVF-related medical malpractice litigation involving genetic testing and fertility clinics have occurred. Within the realm of health law and human rights, instances of wrongful birth claims typically revolve around the desire for a healthy child. Wrongful birth claims occur when a parent of a child who is disabled asserts that the physician failed to warn them about the risks of severe disability adequately (Applebaum et al., 2023; Diab et al., 2015). Genetic testing liabilities in the fertility field have led to various wrongful life and birth claims, such as the case of *Paretta v. Medical Offices for Human Reproduction* (2003) involving a child born with cystic fibrosis through IVF in New York, with donor egg and male partner sperm. The IVF clinic was sued for not disclosing the donor's carrier status or making the couple aware of carrier testing options for the male partner, resulting in a $1.3 million settlement before trial (*Paretta v Medical Offices for Human Reproduction*, 2003). In the *Paretta* case, the court referred to *Becker v Schwartz* (1978), a case in which a mother sued for negligence after giving birth to a child with Down syndrome. She claimed that she was not informed of the increased risk for women over 35 years old or the possibility of detecting the disorder with amniocentesis. Although not an ART case, *Becker v Schwartz* set the precedent that parents could recover the costs of institutional and medical care for a child born with a genetic condition (Amagwula et al., 2012). Similarly, in the case of *Coggeshall v. Reproductive Endocrine Associates of Charlotte, (2007)* a couple claimed they were not informed about PGT before their IVF cycle, leading to a lawsuit involving negligence and informed consent. Attorneys in all these cases often claimed a lack of informed consent and alleged failure to properly inform patients (Amagwula et al., 2012).

Despite the liability concern among a subset of participants, most physicians in this study expressed lesser concern regarding liability. They instead emphasized the significance of delicately navigating the balance between resources and risks within the context of decision-making in private practice. It is worth noting that among all physicians, OBGYNs in the United States are the most frequently sued (Peckham, 2015). Therefore, one could speculate that OBGYNs have become more accustomed to the possibility of facing legal action and are familiar with the responsibility of bearing higher malpractice insurance costs. These factors may influence their decision-making process when considering the advantages and disadvantages of ECS. Of note, when asked about the leading causes of lawsuits, a majority of OBGYN residents identified deficient communication or inadequate documentation, and only 4% of OBGYN

residents believed that lawsuits were predominantly linked to medical malpractice and erroneous physician-directed care (Mathew et al., 2020).

These findings do not imply that physicians are indifferent to the issue of malpractice; instead, they emphasize potential gaps that may exist, particularly as the field of genetics continues to expand within the realm of fertility and ART, which comes with a need for increased understanding in utilizing genetic technologies effectively. Therefore, these circumstances stress the need for enhanced genetics education within medical training and further support for utilizing genetic counsellors and their expertise in fertility clinics. When considering these factors, it is important to acknowledge that no specific studies were dedicated to exploring the attitudes and perspectives of REI providers regarding malpractice claims. Moreover, it is important to note that the referenced litigations were all cases in the United States, and distinct considerations may apply in the Canadian setting due to the significant differences between the two legal systems. Nevertheless, given the often high-stakes nature of their work, it is conceivable that Canadian REI providers could possibly also face potential litigations of a similar nature.

5.3 Fertility Patients Influence FHP Practice

In this study, participants reflected on the unique aspects of providing care to fertility patients. They emphasized that fertility patients are accustomed to making medical decisions regularly and having a sense of control over their reproductive choices. Further, they are uniquely positioned to engage in preconception genetic screening discussions and assess their reproductive options if identified as high-risk with ECS. These factors likely play a significant role in shaping FHP experience and opinions, and the subsequent impact ECS has on fertility patients.

Participants in this study noted that patients using gamete donors, those categorized as "information seekers," and those already undergoing IVF with PGT were more inclined to consider ECS. Fertility patients have been described as “motivated”, “invested”, “well-educated”, “medically savvy”, having “very high expectations,” “anxious”, “information-seeking”, and “demanding” or “challenging” (Liker et al., 2019). Consistent with the idea suggested by participants in this study, which is that fertility patients are well-versed in decision-

making and accessing comprehensive information, Singh et al. (2023) discovered that 57.4% of patients undergoing IVF chose to undergo genetic carrier screening.

Furthermore, it was observed that FHP within this study adjusted their approach and more often broached the topic of ECS if a patient was already considering PGT. Interestingly, previous research has indicated that fertility patients exhibit a greater inclination to pursue PGT-M if a couple is found to be at risk from carrier screening. For example, in the Franasiak et al. (2016) study conducted among couples undergoing IVF, all at risk couples in the study (8/8) intended to undergo PGT-M to avoid an affected birth. In comparison, studies have found that non-fertility carrier couples who have undergone ECS may be less likely to alter their reproductive plans if their carrier status is associated with milder, less severe conditions (Cannon et al., 2019; Ghiossi et al., 2018; Johansen Taber et al., 2019). In the study by Ghiossi et al. (2018), it was observed among couples facing a risk of having a child with a disorder classified as "profound" or "severe", 32 out of 45 (71%) planned to either opt for IVF with PGT-M or, if already pregnant, undergo prenatal diagnosis. While current data suggests that the clinical severity of a disorder influences how couples respond to their carrier status information (Ghiossi et al., 2018; Mathijssen et al., 2018), this may not hold for fertility patients. Studies have shown that fertility patients may be more inclined to pursue PGT-M for disorders characterized as relatively moderate, low-penetrant, or treatable, such as Alpha-1 Antitrypsin Deficiency and GJB2-related hearing loss (Cannon et al., 2019; Ghiossi et al., 2018; Johansen Taber et al., 2019).

It is thought that the heightened interest in ECS among fertility patients may be attributed to the stress and anxiety often associated with fertility treatments, potentially making them more willing to undergo costly tests, treatments, and procedures in their quest for successful pregnancies (Jones et al., 2022). Along with the support demonstrated by genetics professionals for incorporating ECS into fertility/ART based on prior studies (Michalski, 2022; Janssens et al., 2017), these findings indicated fertility patients appear more inclined to adjust their reproductive plans based on ECS results. Therefore, fertility patients may have a higher degree of responsiveness to genetic information, overall making fertility clinics an optimal setting for implementing ECS.

5.4 Barriers

This study identified many barriers and challenges (Table 4) affecting the successful integration of ECS in fertility clinics. This included genetics knowledge among REI physicians, genetic counsellor shortages, clinic priorities, limited professional guidance, and financial aspects of ECS.

5.4.1 Is ECS Beyond the Scope of REI Physicians? A Call for Increased Genetics Education

Most genetic counsellors in this study felt the discrepancies in ECS practices could be partially attributed to physicians' limited awareness of its implications and their perception of it as a low priority. Some physicians in this study expressed reservations about discussing ECS or felt it was outside their scope to handle the results, highlighting the need for genetic counsellors in fertility clinics. Hesitancy among physicians regarding carrier screening has been a longstanding concern, as highlighted in a study by Morgan et al. (2004), in which OBGYNs cited concerns related to their knowledge and ability to interpret positive CF screening test results as reasons for not integrating a routine CF screening program into their clinical practice. Similarly, another study found that only one-third of OBGYNs felt comfortable providing pre-test counselling for carrier screening, and even less (24.9%) were comfortable handling the results (Benn et al., 2014). In the study by Briggs et al. (2018), it was observed that physicians felt more comfortable discussing negative carrier screening results than positive ones. This is not surprising as Delgado et al. (2020) found that only 25% of all physicians reported continuing medical education courses on genetic screening and diagnostic testing, and 18.8% reported never having received any formal training in genetics, including physicians practicing for over ten years who had never completed a continuing medical education course in genetics. Encouragingly, all resident physicians in the Delgado et al.'s study reported receiving formal training on genetic screening and diagnostic testing topics during medical school and expressed comfort more than half of the time in these topics, suggesting an improvement in the genetics knowledge among physicians.

The potential for adverse events in the delivery of genomic medicine underscores the significance of educating non-genetics providers. For instance, one study noted that OBGYNs may lack specific training in interpreting non-invasive prenatal test (NIPT) results, leading to inadequate counselling for families who have consented to NIPT without a comprehensive

understanding of the test's implications (Liehr, 2021). Likewise, a landscape review examining the barriers and facilitators associated with genetic services highlighted various adverse outcomes from genetic counselling and testing conducted by non-genetic professionals (Raspa et al., 2021). These outcomes encompassed issues such as incorrect genetic tests being ordered, misinterpretation of results, insufficient genetic counselling, emotional distress, and providing false reassurance (Raspa et al., 2021). Overall, this provides valuable insight into some of the barriers noted in this study and highlights the importance of formal and informal continuing education in genetics training to improve provider knowledge when implementing ECS into routine practice.

5.4.2 Canada Has a Major Shortage of Genetics Providers

All participants emphasized the necessity for a genetic counsellor's expertise, particularly when dealing with ECS results, or in situations involving relatives or genes where carrier status can carry health-related ramifications. The increasing demand for PGT, the intricacies of gamete donation, the challenges inherent in genetic testing, and the complexities associated with interpreting genetic test results emphasize the indispensable role of genetic counsellors within reproductive medicine (Pasquier et al., 2023; Lilienthal & Cahr, 2020). Participants emphasized that a significant impediment to standardizing ECS lies in the limited pool of accessible genetic counsellors within their clinics, coupled with the constraints of the provincial genetics programs. Despite these concerns about limited access, participants in this study expressed reservations regarding genetic counselling services available through the ECS laboratory. Their concerns stemmed from a lack of familiarity with the testing laboratory services, discomfort, and limited comprehension of the offerings. Additionally, participants noted that these services were unavailable in French, a particularly relevant factor since all study participants reported using an American ECS laboratory. Therefore, we suggest that further dialogue between providers and the ECS laboratories be undertaken, as this resource may be under-utilized in the Canadian FHP setting.

The shortage of healthcare professionals with specialized genetics training in Canada has been a concern for nearly two decades. This issue was first documented in 2002 in the Ontario report *Genetics, Testing, and Gene Patenting: Charting New Territory in Health Care* (Gold et

al., 2002). The report highlighted the relative scarcity of genetic specialists and predicted that this shortage would become more critical as new genetic tests and interventions were introduced. Unfortunately, Canada has not prioritized the expansion of education, training, and funding of more positions in the field of genetics, resulting in extended wait times and high caseloads for clinical genetics providers. The restricted availability of genetics services will only be compounded as the desire for genetic testing continues to grow. A survey by Borle et al. (2022) looked at the perspectives of Canadian genetic professionals regarding the future landscape of clinical genetic and genomic services in Canada. Their results revealed that a significant majority of genetics professionals anticipated a surge in the utilization of carrier screening in preconception settings, alongside expected growth in other clinical genetics areas (Borle et al., 2022). The findings from Borle et al. accentuate the pressing need for human resource planning to improve access to clinical genetic and genomic services for all individuals in Canada, a concern echoed by the participants in within this present study.

5.4.3 ECS is Not a Priority

Participants stressed the presence of competing demands and constrained time, which results in ECS not being positioned as a primary concern for FHP, with the exception for patients using gamete donors. Many highlighted that REI physicians already manage various essential clinic responsibilities, leaving little room to incorporate ECS into consultations. Similarly, genetic counsellor participants also faced time limitations, as they typically had other demanding clinic tasks. Comparable outcomes were evident in a study conducted by Lazarin et al. (2016), wherein a survey of 337 North American genetic counsellors revealed that 53% expressed concerns regarding the time necessary for counselling clients about ECS results, and 59% were apprehensive about the time required to manage follow-up testing coordination. Likewise, American OBGYNs and other professionals involved in reproductive medicine expressed similar reservations about ECS, specifically regarding the duration required for counselling and organizing subsequent investigations for their patients (Ready et al., 2012).

Moreover, within the broader context of infertility, a research study by Duffy et al. (2021) explored the top ten priorities for research investigations in this field, revealing that ECS currently does not hold a prominent position among these priorities. Instead, the top ten research areas encompassed various aspects, including male infertility, female and unexplained infertility

(encompassing age-related infertility, ovarian cysts, uterine cavity abnormalities, and tubal factor infertility), medically assisted reproduction (involving ovarian stimulation, IUI, and IVF), as well as ethical considerations, access, and the organization of care (Duffy et al., 2021).

In addition to these conflicting priorities, the variability in ECS practices among fertility clinics is unsurprising, given the results of this study. While the physicians in this study acknowledged the benefits of having a genetic counsellor in the clinic, their stance on the value genetic counsellors bring was often contradictory to the existing representation in their clinic, where there was hesitancy to increase the number of genetic counsellors. The two REI participants who did not have a genetic counsellor on staff provided reasons for this hesitancy, which included the financial concern of employing a genetic counsellor and the patient volume not high enough to warrant it. Further, genetic counsellor participants also described resistance from physicians in implementing changes related to ECS, which underlines the premise of Recommendation #5: Physician recognition is necessary to offer ECS and support genetic counsellor involvement. Consequently, these conflicting priorities contribute to a culture that may not fully support the invaluable contributions of genetic counsellors. As a result, other individuals, particularly physicians without in-house genetic counselling support or with limited access to it, end up taking on the roles of genetic counsellors, resulting in a divided focus and effort.

5.4.4 Lack of Professional Guidance

Participants in this study expressed feeling impeded by the absence of clear professional recommendations or limited expert direction, leading to challenges in always providing ECS with confidence. Consequently, this situation plays a role in the irregular practices evident across various clinics observed in this study. Comparable concerns about ECS were also noted in North American genetic counsellors (Lazarin et al., 2016) and interviews with 17 Dutch health policy and patient organization representatives (Van Der Hout et al., 2017). Participants in both studies remarked on the necessity for enhanced infrastructure, improved guidelines, comprehensive education, and more effective counselling tools. These studies voiced similar concerns brought up by participants in our present study, which is that introducing ECS prematurely might overwhelm patients with information, increasing the likelihood of it being overlooked or not understood entirely (Lazarin et al., 2016; Van Der Hout et al., 2017). Similarly, Cho et al. (2013)

explored American genetics professionals perceived barriers to offering ECS and echoed the findings of our present study, where concerns stemmed from a lack of guidelines on when ECS should be offered. Finally, demand for standardized Canadian guidelines regarding ECS emerged in a mixed-methods study involving Canadian genetics professionals (Michalski, 2022). Participants in the Michalski (2022) study pointed out that the existing carrier screening guidelines provide vague and occasionally conflicting recommendations. Additionally, they highlighted that some of these guidelines may not fully encompass the capabilities of newer technological advancements in carrier screening (Michalski, 2022).

5.4.5 Perceptions and Considerations of Costs

Within this study, participants expressed concerns about expenses associated with ECS in various contexts, spanning all four categories. For certain participants, costs were cited as a barrier, while others raised the matter within the framework of ensuring fair access or striking a balance between resources and risks when making decisions within the scope of private practice. Participants in this study displayed distinctive characteristics, distinguishing them from healthcare professionals in other Canadian domains. We observed that participants in the present study are accustomed to patients privately covering healthcare and treatment costs, and therefore, hypothesizing that this dynamic may influence the culture within Canadian fertility clinics. Interestingly, despite our participants' notion that costs might pose a theoretical obstacle to accessing this test, none of the study participants recounted instances where a fertility patient refrained from pursuing ECS due to financial concerns. More participants felt that the cost of ECS is comparably modest in relation to the costs of fertility treatments. They suggested that patients who invest significant financial resources in attaining pregnancy should be well-informed about the potential risks associated with genetic conditions.

These study findings suggest that since FHP are accustomed to higher-cost treatments, they likely view the expense of ECS as a comparatively minor barrier compared to providers in non-private settings. This concept is further reinforced by the findings in Michalski's (2022) study, where Canadian genetics providers in private settings, such as fertility, more often discussed ECS than their counterparts in public genetics clinics. It was suggested that genetics providers in private clinics might encounter fewer challenges than those in public healthcare, potentially facilitating the routine discussion of ECS (Michalski, 2022).

The findings in this study, alongside parallel North American investigations (Cho et al., 2013; Michalski, 2022; Ramdaney et al., 2022; Sagaser et al., 2023), indicate that perceptions regarding the costs of ECS differ significantly among healthcare providers. While this does not diminish the significance of factoring in immediate and long-term financial factors when discussing ECS, the provider's perception of cost and the client's financial capacity should not serve as reasons to withhold carrier screening, as such an approach would exacerbate healthcare inequalities (Sagaser et al., 2023).

Lastly, when discussing the aspect of costs acting as a barrier for ECS, numerous participants approached this matter using a systems approach by considering fertility clinics as business entities. They looked at costs in terms of genetic counselling services, clinic fees, PGT expenses, on-site blood draws, shipping, and staff compensation. These additional costs collectively hinder ECS accessibility. Stoll and Resta (2013) argued that the true costs of ECS include follow-up counselling needs and what carrier individuals and couples actually do with the information and investigations. This information is often not included in marketing claims when considering the "affordability" of ECS, with some testing companies only including vague interpretations of the significance of carrier status in their marketing materials, such as "optimizing pregnancy outcomes" and "informing family planning" without further explanation on these claims.

5.5 Changes and Recommendations: Enhancing ECS Delivery

In this study, participants provided multiple recommendations and changes that could help enhance the provision of ECS within fertility clinics (Table 5). These included improving the way and when ECS is offered, alternative pre-test counselling methods, incorporating ECS into public healthcare, increased support from the ECS laboratories, and genetic counsellors requiring physician support for implementing ECS improvements.

5.5.1 ECS Should be Offered Pre-Conceptionally

Participants in this study all agreed that the concept of ECS should be introduced pre-conceptionally, ideally during the initial fertility consultation, and further information that is accessible and understandable should be available at various points during a patient's journey. Several studies have shown consistent findings that support the optimal time for ECS is

preconception, as it maximizes reproductive choices and allows for informed decision-making regarding reproductive genetic risks (Benn et al., 2014; Cho et al., 2013; Holtkamp et al., 2017; Schuurmans et al., 2019). Within this study, participants provided recommendations on how ECS could be introduced (Recommendation #1), such as increasing the frequency and format of information available to clinics about ECS. Further, some participants noted that patients often had limited awareness or misconceptions about ECS. These findings were also demonstrated in a study by Van Steijvoort et al. (2023), who found the informational brochures on ECS, which their participants received via email before their pre-test counselling sessions, were fully read by only 66% of the participants. The study recommended providing information at multiple time points and through various means to enhance understanding and awareness (Van Steijvoort et al., 2023). Additionally, a supporting study with European geneticists suggested using unbiased educational resources that address the limitations of ECS to avoid overloading parents during consultations and ease the workload for healthcare providers (Janssens et al., 2017).

5.5.2 Novel Approaches to Pre-test Counselling and Support from ECS Laboratories

There was a consensus among participants that a genetic counsellor may not always be necessary, particularly for ECS pre-test counselling (Recommendation #2). One physician expressed concerns that mandating the involvement of a genetic counsellor could serve as an additional obstacle to accessing ECS. This concern aligns with findings from Pasquier et al. (2023), who noted that providing genetic counselling might be perceived as a barrier by reproductive providers. The majority of participants in this study agreed that alternative healthcare professionals, such as nurses, genetics assistants, and physicians, could deliver basic ECS counselling if adequately trained and were capable of ensuring informed consent.

Moreover, participants in this study also highlighted the challenges associated with delivering comprehensive pre-test counselling and obtaining informed consent for ECS. An underlying concern in the literature regarding ECS pertains to individuals' capacity to provide informed consent when being tested for multiple conditions (Delatycki et al., 2020; Van Der Hout et al., 2017). While this study did not extensively delve into the topic of informed consent, the study by Briggs et al. (2018) reported that REI physicians felt ECS should only be offered when the significance of each disease is fully comprehended, and that testing should be restricted

to conditions deemed significant for the couples. Similar challenges have been documented in other studies (Delatycki et al., 2020; Van Der Hout et al., 2017; Lazarin et al., 2016), and some have provided suggestions for alternative approaches to the necessity of a genetic counsellor for ECS. In one study, genetic counsellors proposed a universal consent model encompassing a tiered approach for pre-test information. In this approach, ECS panel diseases could be grouped into categories based on shared characteristics (Pasquier et al., 2023).

The ACMG guidelines noted that traditional genetic counselling models could be time- and labour-intensive (Gregg et al., 2021). Thus, new models must be developed and instituted for training non-genetic providers and counselling patients. These models might include videos, chatbots, computer-based learning, or other methods of providing information to patients and assessing their understanding (Gregg et al., 2021). Moreover, the participant-driven recommendations in this study resonate with the findings from Pasquier et al. (2023), where respondents believed that non-genetics healthcare providers could deliver overarching information during counselling sessions and refer to supplementary materials like pamphlets, brochures, audio-visual aids, or websites for more comprehensive information about ECS (Pasquier et al., 2023). Similarly, Lazarin et al. (2016) demonstrated that 67% of genetic counsellors agreed that adequately trained health professionals could provide such counselling, and another 31% felt that informational brochures or videos would suffice for pre-test counselling. Likewise, most participants in the Michalski (2022) study believed that with additional training, obstetricians would be best suited to perform pre-test counselling for ECS, followed by gynecologists and family physicians.

This consistent call for educational materials for both patients and healthcare providers could be supported by the suggestion from our participants that ECS laboratories could drive the creation of these resources. However, in retrospect, it is interesting to note many of these resources are in fact are available already on ECS laboratory websites, as well as information about externally contracted genetic counselling services. As our participants cite barriers to use these external services, such as lack of familiarity, discomfort, and limited comprehension of the offerings, further exploration is warranted to determine why they may be unwilling to explore existing materials on their own. Chokoshvili et al. (2018) is the only known study to investigate the genetic counselling services available from ECS laboratories by analyzing the marketing

materials of these companies available on their websites. Their findings revealed that pre-test genetic counselling was not uniformly included for most companies, and customers desiring pre-test genetic counselling typically needed to make a specific request. Additionally, the study reported that six of 16 companies offered complimentary post-test genetic counselling to all consumers, regardless of their test results, while three companies restricted routine post-test genetic counselling to consumers with positive carrier screening results (Chokoshvili et al., 2018). Further research is needed to explore the patient and provider experience using genetic counselling services through ECS companies, which could better address the issues brought up by our participants.

5.5.3 The Public Health System Should Offer ECS

Participants in this study advocated for including a discussion about ECS as a routine component of pre-conception care. This was supported by over half (61%) of Canadian genetics providers in the Michalski (2022) study, in which genetics providers believed that ECS should be funded by public healthcare in any prenatal/preconception setting. Many participants in the present study also emphasized the importance of enhancing ECS accessibility through the public health system, specifically by integrating it into the practices of primary care physicians and OBGYNs (Recommendation #4). While some participants acknowledged the potential challenges associated with implementing such a change, it is worth noting a pilot qualitative study, conducted by Schuurmans et al. (2019), trained general practitioners (GPs) in the Netherland in offering population based funded ECS and found success in this endeavour. The findings from Schuurmans et al. align with the proposed recommendations of the participants in this research, suggesting that GPs are well-suited to oversee large-scale implementation of population based ECS, with education and training. Further, Schuurmans et al. also revealed that 91% of patients expressed high levels of satisfaction with GP counselling, and 14% of eligible couples accepted ECS when offered by their GP, further indicating that the provision of ECS is indeed feasible and of interest to patients when administered by well-trained and motivated GPs.

Indeed, one of the primary Canadian obstacles to incorporating discussions about ECS into routine pre-conception care is providing a private-pay test within a public healthcare framework. As noted by participants in this study, costs can pose a hurdle for patients, and the

Canadian population's unfamiliarity with medical expenses can further complicate the adoption of ECS in the public healthcare context. Though this may be less applicable in the context of fertility, as mentioned earlier, the patient culture within this field indicates a greater inclination to pay out-of-pocket for tests, treatments, and procedures that provide them with more information in their pursuit of a successful pregnancy (Jones et al., 2022). Genetic counsellors possess the expertise necessary to play a pivotal role in developing resources and educational programs tailored to the needs of routinely integrating ECS into fertility clinics and, eventually, for population-wide prenatal and preconception settings (Edwards & Laing, 2022).

5.5.4 Collaboration between Genetic Counsellors and REI Professionals in Fertility

REI physicians expressed a strong appreciation for the expertise and insights provided by genetic counsellors. While they endorsed the concept of novel approaches or alternatives to ECS pre-test counselling, there was a unanimous agreement among participants that the involvement of a genetic counsellor remains indispensable in certain situations, particularly when interpreting ECS results. Nonetheless, despite recognizing the value of genetic counsellors, two participants worked at clinics without a genetic counsellor on staff and encountered challenges in justifying the addition of one. Furthermore, in most clinics, genetic counsellors were limited, with many having only a part-time genetic counsellor or just one or two genetic counsellors available or limited availability of their genetic counsellors due to non-ECS counselling tasks such as PGT counselling. As the demand for genetic testing and services increases, the integration of genetic counsellors into fertility clinics is becoming a growing need. A study by Benammar et al. (2023) highlighted the significant advantages of having an on-site genetic counselling unit, emphasizing its convenience and ability to streamline ART treatment. Furthermore, all couples offered counselling in their study accepted the opportunity. Previous research has also supported alternative genetic service delivery models, such as a team-based or collaborative approach involving genetics and non-genetics providers (Hartley et al., 2011; Kubendran et al., 2017).

Genetic counsellors participating in this study voiced difficulties when introducing changes and enhancements to ECS. They expressed a strong need for greater support from the physicians in their clinics (Recommendation #5). The genetic counsellor participants believed that, before suggesting any alterations to the clinic practices, it was imperative to improve the

physicians' comprehension and recognition of the value and practicality of ECS. Some genetic counsellors even felt responsible for educating the physicians they collaborated with to ensure a full appreciation of the benefits of ECS. Genetic counsellors in one study suggested applying formal case-based learning and informal education during routine interactions with non-genetics healthcare providers in the workplace could make a positive impact on clinical practices (Coleman et al., 2023). Their findings stressed the critical nature of collaboration between non-genetics and genetics professionals to enhance service provision.

Similarly, East et al. (2022) demonstrated the effectiveness of such initiatives using an interactive training intervention and was found to enhance providers' confidence, knowledge, and proficiency in reviewing and interpreting genetic test results. Interestingly, genetic counsellor participants in the present study proposed a role for ECS laboratories in providing educational materials to support medical professionals, which helps increase awareness and education for non-genetics providers. It is not known how receptive REI physicians would be to such educational interventions, and evaluation would be needed following such interventions.

LIMITATIONS

This study aimed to encompass a diverse range of provider views, with parity in the sample size of genetic counsellors and physicians. It reached thematic saturation after interviewing 11 participants (Figure 5), with a response rate of 33% for ART genetic counsellors and 11.7% for physicians who participated. However, the small sample size of participants may restrict the full scope of clinic practices, values, opinions and experiences within the fertility field. Moreover, as only one representative from each clinic was typically interviewed, the collective clinic perspective might not be fully represented. The sample may also be limited by participant selection bias, given that those with a pronounced interest in the subject matter may have been more inclined to participate. Additionally, participants with more extensive genetics training could potentially harbour greater knowledge and familiarity with the topic. Despite our efforts to balance participants' viewpoints, the extent of genetics training among providers could have influenced the diversity of perspectives captured. Therefore, the views presented may not comprehensively reflect the entirety of perspectives within the FHP community.

While our results and discussions aimed to feature the influence of fertility patient culture on the perspectives regarding ECS, it is important to acknowledge that these insights were collected through the lens of FHP, without direct input from fertility patients themselves, potentially impacting the accuracy of depicting the "culture of fertility patients." Further, as participants working within the fertility specialty were interviewed, the transferability of these results may be limited when applied to other preconception care providers who cater to a different demographic of patients. Further study of patient interest in ECS is warranted to compare this to provider perceptions.

It is also worth considering that the participants in this study were interviewed before the release of the latest position statement by the NSGC (Sagaser et al., 2023) on ECS practices. It is possible that the attitudes of genetic counsellor participants, particularly regarding the need for enhanced professional guidelines, could have evolved since then. However, the NSGC's statement is through an American organization and is not a binding guideline. It may have had limited reach among physicians in the fertility field or the Canadian context. Furthermore, in the Canadian context, the lack of updates to carrier screening recommendations by relevant professional organizations, such as SOGC or CCMG, would bear greater influence concerning practices and FHP views on ECS in Canada.

Lastly, this study draws numerous comparisons with studies involving European and American providers working in the ART field, and one must carefully consider how transferable the findings of these studies are to Canadian healthcare systems and policies. It is also worth noting that while a great deal of fertility practice in Canada falls under private healthcare, it is important to recognize that comparisons with US providers may not be perfectly analogous due to the distinctly private healthcare system in the US, which differs from the Canadian healthcare landscape. Further, it is also worth noting that many of these studies were conducted several years ago, so any comparisons should be approached with caution, considering the significant changes that have occurred since.

FUTURE DIRECTIONS

This study has provided valuable insights into the experiences and viewpoints of FHP regarding ECS. However, several areas within this field warrant further exploration. These areas

include delving into the fertility patient experience with ECS, implementing and evaluating the ECS recommendations provided by our participants, exploring how cost factors into how clinics offer and interact with ECS, and evaluating REI physician genetics educational interventions.

One of the first critical areas for future investigation should be studying fertility patients who have undergone ECS, explicitly focusing on informed-reproductive choice as an outcome versus testing uptake. Understanding the impact and how ECS influences their subsequent reproductive decisions and family planning is essential to providing insights into the impact of ECS. Second, participants in the study made several recommendations where changes could be made to improve the provision of ECS. Future research could study the effectiveness of these ECS recommendations, such as developing and evaluating novel ECS counselling approaches, namely patient education models for pre-test education.

Third, while the cost of ECS testing itself is decreasing, there is a need for comprehensive research on a holistic view of the financial factors associated with ECS. This includes clinics' costs in pre- and post-testing counselling, particularly focusing on the time and resources involved. This could also clarify the financial implications of employing genetic counsellors within fertility clinics.

Lastly, this study has identified hesitancy among physicians regarding their knowledgeability and confidence in the genetics aspects of ECS. Future research can explore genetics education in Canadian medical training as part of continuing education, residency programs, and medical school curricula to assess if it is adequate given physicians' increasing interactions with genetic testing. In conclusion, these future research directions aim to contribute to a deeper understanding of ECS, facilitate evidence-based improvements in healthcare practices, and ultimately enhance the quality of care provided to individuals and couples seeking reproductive assistance.

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APPENDIX

APPENDIX A: Recruitment Materials

Recruitment Email Invitation

SUBJECT: Expanded Carrier Screening in Canadian Fertility Clinic Study

Dear Potential Participant,

My name is Michelle Morello, 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 the integration of expanded carrier screening within Canadian fertility clinics."** This study is part of my MSc Genetic Counselling thesis project.

Study Description: The goal of this study is to interview fertility healthcare providers to explore when, how, and the ways Expanded Carrier Screening (ECS) is offered in Canadian fertility clinics.
Your participation will help us better understand the successes and challenges of the integration of ECS in Canadian fertility clinics, as well as understand fertility healthcare providers general opinions and attitudes of ECS. We hope the study results will help address the service needs and gaps related to counselling fertility patients about ECS and assist fertility providers in improving patient care.

You may be eligible to participate in this study if:

- You are a healthcare provider working in the fertility setting in Canada
- You have at least 1 year experience in the fertility setting
- You provide some form of reproductive counselling to patients (i.e., talk about pregnancy options, carrier screening etc.)
- You are proficient in English

Your Role: We hope to learn more about your experience, challenges, and opinions of ECS through a 30–45-minute interview. If you are interested in participating in this study, please respond to me by email morellom@myumanitoba.ca stating your interest. Once we hear from you, a link to a five-minute online questionnaire will be sent to help gather some preliminary information about you and how your clinic interacts with ECS, which will be used to tailor your interview.

I look forward to hearing from you.

Sincerely,
Michelle Morello

APPENDIX B: Online Screening Questionnaire

Screening Questionnaire

1. Do you currently work in the fertility setting in Canada?
    - o Yes
    - o No
2. Are you proficient in English?
    - o Yes
    - o No
3. Do you do reproductive counselling with patients (i.e., talk about pregnancy options, screening)?
    - o Yes
    - o No
4. Does your clinic offer Expanded Carrier Screening*?
    - o Yes
    - o No

* Expanded Carrier Screening for the purpose of this research is defined as reproductive genetic carrier screening offered beyond one's ethnicity and family history. Expanded carrier screening panels generally screen for 100+ genes at one time and is paid for out of pocket by the patient.

5. Your responses above will inform your interview. In order to link the two, please provide your first name and last initial (fill in box):
   _____

6. How many years' experiences do you have in the fertility field?
   o 1 – 4 o 5 – 10 o 10 – 15 o 15+

7. What are your credentials?
   o MD o Licensed/Registered Nurse o CCGC/CGC o Other

   a) If MD, please indicate specialty _____
   b) If other, please provide details: _____

8. What province or territory do you practice in? (Check all that apply)
   o BC o AB o SK o MB o ON o QC
   o NL o NS o PE o NB o YT o NT
   o NU

9. What Expanded Carrier Screening tests are most frequently offered in your clinic? (Check all that apply)
   o Invitae o Sema4 o LifeLabs o Fulgent Genetics o Other
   a. If other, please provide details:_____

10. Who provides Expanded Carrier Screening **pre-test counselling**? (check all that apply)
○ MD ○ Nurse ○ Genetic Counsellor ○ Other

a) If MD, please indicate specialty _____
b) If other, please provide details: _____

11. Who provides Expanded Carrier Screening **post-test counselling**? (check all that apply)
○ MD ○ Nurse ○ Genetic Counsellor ○ Other

a) If MD, please indicate specialty _____
b) If other, please provide details: _____

APPENDIX C: Consent Forms

Online Consent Disclosure Statement

Dear [Participant Name],

Thank you for your interest in our research study "*Exploring the integration of expanded carrier screening within Canadian fertility clinics*. The goal of this study is to interview fertility healthcare providers to explore when, how, and the ways Expanded Carrier Screening (ECS) is offered in Canadian fertility clinics. This study is part of Michelle Morello's MSc Genetic Counselling thesis project at the University of Manitoba.

We hope to gather some preliminary information about you and how your clinic interacts with expanded carrier screening in this five-minute questionnaire. All responses will be kept confidential; however, as **your responses to this questionnaire will be used to inform your interview,** we do require your first name and last initial. The survey system will not record your IP (Internet protocol) address. Digital information gathered will be stored as secure files on a password-protected computer.

Your participation is completely voluntary. The risks of participating are low. It is possible that thinking about past experiences might be upsetting, emotional, or distressing for you. There will be no direct benefit for participation in this study, although we hope our data may be useful to future practice.

Following the completion of this questionnaire, select participants across Canada with different backgrounds and experience will be contacted to set up an interview. Information provided by participants that are not interviewed will not be included in this study. If you have questions, please contact the student investigator, Michelle Morello, morellom@myumanitoba.ca or the supervisors jessica.hartley@umanitoba.ca and claudia.carrileslandry@umanitoba.ca

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 xxx-xxxx or by email at

bannatynereb@umanitoba.ca. Please feel free to print a copy of this consent page to keep for your records.

By continuing and completing the questionnaire, you are consenting to the above.

To access the online questionnaire, please follow this web link: [insert REDCap URL here].

Thank you for your participation!

Michelle Morello, BSc
Genetic Counselling Trainee

Interview Consent Form

CONSENT FORM FOR PARTICIPANT

Individual Interview

Study Title: *Exploring the integration of expanded carrier screening within Canadian fertility clinics*

Student Investigator: Michelle Morello, BSc

Supervisors: Jessica Hartley, MS, CGC
Claudia Carriles Landry, MS,CGC

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 Michelle Morello, 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 co-supervisors for this study are Jessica Hartley, a board-certified genetic counsellor and the Program Director of the Genetic Counselling Program at the University of Manitoba, and Claudia Carriles Landry, a board-certified genetic counsellor and the Co- Director of the Genetic Counselling Program at the University of Manitoba.

PURPOSE OF STUDY

This study aims to explore the experiences and practices related to Expanded Carrier Screening (ECS) among Canadian fertility specialists. We to hope to better understand the successes and challenges of the integration of ECS, and fertility healthcare providers general opinions and attitudes of ECS. We hope the study results will help address the service needs and gaps related to counselling fertility patients in this setting, with the hope this can be extended to other specialties in the future.

PARTICIPANT SELECTION

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

- ✓ Have at least 1 year experience in the fertility setting AND
- ✓ Provide reproductive counselling with patients (i.e., talk about pregnancy options, screening)?

STUDY PROCEDURES

- The student investigator will deliver an online screening questionnaire prior to the interview to determine if you qualify for this study. We are hoping a total of 12-16 participants will complete an interview
- The interview will be conducted over University of Manitoba Zoom (UM Zoom) by the student investigator, Michelle Morello. The interview will be approximately 30 – 45 minutes in length
- You will be asked questions about your personal experience and opinions with ECS in the fertility setting
- These questions will help us better understand how clinics have integrated ECS into their practice to improve how ECS is offered to fertility patients in the Canadian Health Care system
- 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 are upsetting. We will do our best to maintain confidentiality. However, because the fertility specialty 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 develop participant-driven recommendations to improve the integration of ECS into routine practice and identify resources that could be helpful to help overcome challenges Fertility Healthcare Providers face with providing ECS.

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 enrollment 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 2023.

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, Michelle Morello at morellom@myumanitoba.ca. You may also contact the student supervisors, Jessica Hartley at jessica.hartley@umanitoba.ca and Claudia Carriles Landry at claudia.carrileslandry@umanitoba.ca

If you have questions about your rights as a research participant, you may contact the University of Manitoba Bannatyne Research Ethics Board by phone 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): £

Participant 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: 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 to not answer a question, or if you would like to take a break at any time.

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

1. Confirm answers to screening questionnaire
2. Tell me a little bit about your clinic? (Physicians on the team, size, catchment area)

Topic 1: Overall Opinions of ECS

1. How integrated is ECS in your clinic?
   - For example: offered to all patients, those who request it, those who get it elsewhere, those who are donors?
   - What is going well in this process?
   - What is an example of something could be improved?
   - What trends are you noticing in patients who do ECS (IVF vs IUI, SES, ethnicity)?
2. How are patients being impacted by ECS?
   - What are their reactions/emotions? (ex: reassured, empowered, anxious, overwhelmed)?
   - How do they use this information? (Example: Opting to do PGT or prenatal testing)

3. What is your personal opinion on offering ECS in the fertility setting?
   - Do you feel it should be offered to all patients? Certain Patients? Why?
   - Is this different from who you are seeing access it in your practice?
   - Are there reasons ECS is not being offered to every patient currently?

Topic 2: Challenges and Resources

1. What challenges or barriers have you experienced in trying to implement ECS into your clinic?

- For example: Difficulties in accessing pre/post-test counselling, patient expectations, timing of patient's cycle/other tests, scheduling, cost of test, logistical issues such as sample collection or shipping)
- Can you provide an example?
- What might be some ways to improve getting this information to patient?

2. Has your clinic made any changes to mitigate some of these barriers (staffing, training, educational resources, etc)?
   - What do you think needs improvement in the way you are offering this service?
   - What resources are missing that you think would be helpful? (Or other participants have mentioned x,y,z as barriers, what resources could be helpful?) (trying to learn what resources are currently being used to address challenges and if GCs have been a part or could be a part of that)
   - People/Training: Hiring a genetic counsellor or more GCs? Training other staff members such as nurses to assist in counselling?
   - Educational Resources: Using or creating an educational resource for patients such as a pamphlet or video?
   - How do you think ECS labs could support your team?
3. In an ideal world, with unlimited resources and no barriers, what do you think is the best way to integrate ECS into Canadian fertility practice?
   - How do your opinions about ECS change in this circumstance?

[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. Thank you once again. Take care.