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THE IMPACT OF A LYNCH SYNDROME DIAGNOSIS BY POPULATION GENOMIC SCREENING ON FAMILY COMMUNICATION, MEDICAL MANAGEMENT, AND LIFESTYLE CHANGES

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Master of Science in Human Genetics

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Abstract

The purpose of population genomic screening programs is to help in prevention and treatment of conditions that takes into account an individual's unique genetics, environmental, and lifestyle factors. Through this "genome-first" approach, individuals at increased lifetime risk for certain conditions are identified, allowing them and their relatives to qualify for preventative medical care and surveillance (Schwartz et al., 2018). An example institution that utilizes this approach is Geisinger's MyCode Community Initiative, where their goal is to "make healthcare better" through research and its application to patient care (MyCode Community Health Initiative, n.d.). MyCode reports back medically actionable results for conditions associated with increased risks for cardiovascular diseases and developing cancer. One of the hereditary cancer syndromes that MyCode reports back to clinical care is Lynch syndrome (LS), a condition with nationally recognized guidelines for preventative surveillance measures. MyCode participants with an LS-associated variant have an interdisciplinary approach to medical care made available to them, being offered optional access to methods of facilitating family communication, instituting changes to medical management, and considering lifestyle modifications. In this study, 17 MyCode participants who received actionable LS results were interviewed to assess potential facilitators and barriers affecting family communication, follow-up medical care, and modifying lifestyle.

Keywords: Lynch syndrome, hereditary cancer syndrome, family communication, medical management, lifestyle modifications, population genomic screening.

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Introduction

Lynch syndrome (LS), also known as Hereditary Non-Polyposis Colorectal Cancer (HNPCC), is an autosomal dominant condition that presents as a result of inheriting a pathogenic variant in one of the five genes involved in the Mismatch Repair (MMR) pathway, *MLH1*, *PMS2*, *MSH2*, *MSH6*, and *EPCAM*. This syndrome is characterized by an increased risk for biological males and females to develop colorectal cancer (CRC) in their lifetime, anywhere from 20%-82% for both sexes with a mean age at diagnosis of 44-61 years (Kohlmann & Gruber, 2018; Key Statistics for Colorectal Cancer). Endometrial cancer also poses an increased risk for biological females, up to a 46% chance for developing this cancer type in their lifetime, along with elevated risks to develop ovarian cancer (Kohlmann & Gruber, 2018). There is also an increased risk for both sexes to be diagnosed with cancers of the biliary tract, brain (esp. glioblastomas), pancreas, prostate, skin (esp. sebaceous adenomas, sebaceous carcinomas, and keratoacanthomas), small bowel, stomach, and urinary tract (Kohlmann & Gruber, 2018). The wide variability in risk percentages and uncertainty surrounding the development of LS-related cancers is due to the fact that each gene involved in the MMR pathway is associated with different risks for the variety of cancer types, in addition to the influence of other contributing genetic and environmental factors (Kohlmann & Gruber, 2018). An individual who has been diagnosed with LS should be provided with a comprehensive overview of the management process in order to understand how to appropriately attend to their care moving forward.

Upon receiving an LS-associated variant, patients are faced with a multitude of decisions pertaining to medical management, lifestyle modifications, and whether or not they would like to communicate their genetic information with their family members. Medical management recommendations revolve around the consideration of preventative surveillance measures, such as

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scheduling annual/biannual colonoscopies, upper endoscopies every 3-5 years, and annual dermatologic exams (Lynch syndrome, 2019). The benefit of increased surveillance can be exemplified by colonoscopies, which have been found to play a role in identifying cancers early and preventing colorectal cancer altogether by removing certain types of polyps, thereby extending the lifespan (Grover & Syngal, 2010). Prophylactic surgery options are also given to females as options, such as obtaining a hysterectomy and/or risk-reducing salpingo oophorectomy (RRSO), once childbearing is complete. Recommendations for maintaining a healthy lifestyle involve keeping up with a diet that is high in fruits and vegetables and low in red meat, little to no alcohol consumption, a dedication to exercise and maintaining a healthy weight, and a cessation of smoking (Burton et al., 2010). When an individual is identified to have an LS variant, that information is important for their relatives' health care given that LS is inherited in an autosomal dominant manner (Kohlmann & Gruber, 2018).

"Genome-first" clinical encounters, or those where patients present to care based on a genomic finding, preceding any manifestations of features, are increasing as a result in the uptake of genomic sequencing (Schwartz et al., 2018). Whether it be for research or for clinical utility, there has been a decrease in cost and an increase in the ability to analyze genomic databases for medically-actionable variants (Schwartz et al., 2018). Programs such as these are able to identify patients who are at higher risks to develop a phenotype on a genomic level, allowing them to present to care for increased surveillance, medical treatment, and additional preventative measures that are targeted to their condition prior to experiencing symptoms (Schwartz et al., 2018). Geisinger's MyCode Community Health Initiative, which has a goal to "make healthcare better" through research and the application of that research to patient care, is an example of an

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opportunistic genome screening program that provides such "genome-first" care (MyCode Community Health Initiative, n. d.).

MyCode returns actionable genetic results to clinical care if participants are identified to carry a pathogenic/likely pathogenic variant in one of twenty-five conditions, including LS (Frequently asked questions, n. d.). As of February 1, 2020, a total of 1,489 participants have received results, of which 175 of them are LS-related (MyCode Community Health Initiative, n. d.). Results are disclosed over the phone by a genetic counselor. Participants are offered a follow up genetic counseling visit for education and psychological support. Participants with results also receive a summary letter with details about LS cancer risks and management recommendations, a copy of their genetic test report, and a "Dear Family" letter or online family sharing tool to aid in sharing the results with at-risk relatives. The result is uploaded to their Electronic Medical Record (EMR) and their primary care provider is notified. Geisinger's Inherited Risk Gastrointestinal (IRGI) clinic is a multidisciplinary clinic where a variety of specialists are available to educate and coordinate care related to LS surveillance and prevention options. In this study, we interviewed MyCode participants identified to have an LS-associated variant about how receiving a positive genetic test result impacts how they have been communicating the information with their at-risk relatives, following medical management recommendations, and implementing lifestyle modifications.

Methodology

Study Population and Data Collection:

This qualitative study conducted in-depth, semi-structured phone interviews with participants from MyCode, who had been found to have an LS-associated variant (Creswell, 2007). We gathered the personal responses of these participants regarding their experiences in sharing the genetic

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information with at-risk relatives and following recommended medical guidelines and lifestyle modifications. We utilized Geisinger's MyCode program records containing 126 individuals who were identified to have LS. From MyCode's contact directory, we recruited participants who were 18 years of age or older to request their participation, obtained their consent to participate, and scheduled the telephone interview date and time. The interview questions focused on eliciting patient experiences with communicating their MyCode genetic test result to their family members, how they have navigated associated medical management recommendations, and what lifestyle modifications they have pursued. Examples of interview questions for each domain are as follows in Figure 1.

Figure 1: Examples of Semi-Structured Interview Protocol Questions for Primary Domains

Family Communication
How did you choose to communicate this genetic information with them?
Tell me what is preventing you from sharing it with your family?
What support do you think would help you share this with family?
Medical Management
What have you been doing differently regarding your healthcare choices, if anything, since receiving your MyCode results?
What, if any, issues did you have in getting insurance to cover your care related to Lynch syndrome?

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Describe what your experience has been like staying on top of these healthcare choices during the COVID-19 pandemic?
Lifestyle Modifications
What recommendations have you been told or seen?
What recommendations have you followed, if any?
How did other sources, if any, influence your past choices regarding the recommendations proposed to you?

Interviews were conducted between December 2020 and January 2021. A consent statement was read before beginning the interview to obtain participant's consent to audio recording the interview. The interview questions elicited personal responses from the participants regarding their experiences pertaining to their LS-associated variant disclosure. Each interview lasted for 30 to 45 minutes, were de-identified upon completion, and were sent for transcription. Once data collection was completed, participants were thanked for their participation in the form of a $20 Amazon gift card.

Data Analysis:

Interviews were coded iteratively in levels using ATLASti.8 software. First, we engaged in open-coding to identify initial themes amongst participant responses that began to answer the project's research questions. Emergent themes from open-coding were broadly classified into facilitators and barriers of participant's actions related to family communication and health care management. Using Owen's thematic interpretation criteria (1984) as a guide, we were able to identify key themes to further categorize our interview data. Our second-level coding process was characterized

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by naming specific facilitators and barriers for (a) family communication about LS results, (b) lifestyle modifications related to LS, and (c) medical management to reduce cancer risks related to LS. These facilitators and barriers were captured in a table with exemplar quotes and reviewed by the study team. Through this table, we compiled the code book that was acknowledged throughout the data analysis process. To initiate the third-level coding process, an axial coding protocol was followed and the open codes were related to one another via an established code name and meaning of the code (Saldana, 2013). Finally, we refined and expanded on themes and subthemes within each of the three domains to identify connections among facilitators and barriers related to communication and health outcomes. Exemplar quotes are included below to provide a thick description of each theme of facilitators and barriers within each of the three domains.

Results

Seventeen phone interviews were completed with 8 male and 9 female participants (see Figure 2 for participant age distribution). After qualitative analysis of these interviews, three overarching themes emerged: [1] communicating genetic risk information to family members, [2] changes in medical management, and [3] changes in lifestyle modifications. Each major theme included both facilitators and barriers that influenced participants' action regarding family communication, changes to their medical management, and implementation of particular lifestyle modifications.

Figure 2: Participants Characteristics (N = 17 individuals)

Age	30-50 (N = 4) 51-70 (N = 8) 71-90 (N = 5)
Sex	Female (N = 9) Male (N = 8)

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Pathogenic/Likely Pathogenic Gene Variants	*MLH1* (N = 3) *MSH2* (N = 2) *MSH6* (N = 7) *PMS2* (N = 5)

Communicating genetic information with family members

All participants reported that sharing this information with their relatives was crucial. Participants elaborated on who they chose to communicate information about their genetic test result with in their family, highlighting common barriers and facilitators of sharing the genetic information.

Facilitators

Participant perceptions of their duty to share results with family. All participants said they valued how important these genetic test results were to share with their immediate family members. They described how their concern for increased risk for LS-related cancers and the qualification for increased surveillance options motivated their sharing behaviors with at-risk relatives. Exemplary quotes from two participants are as follows:

> *"I felt, like, some obligation to do it I guess, some concern for them, that if this could help protect them, help to detect a problem early. I wanted them to have that information available to them. I wanted them to be able to have that same level of care that I have."*
>
> *"That was frustrating because as a mother you want your children to be healthy. The only things I really, really want for my children is to be happy and healthy. And I could say sometimes there are a lot of things you can't control with happiness, but the healthy part that as well, there are some things you can kind of try to be proactive about is your health, so I presented this information that I had with my children…"*

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Being a parent and the feelings surrounding raising children was found to be a large component of why participants chose to share their genetic results with their children. Feelings of concern, wanting the best in terms of healthcare, and the desire for their children to live a happy and healthy life dominated their reported reasons to communicate LS variant information with their children. It was also observed that children who received this information first felt obligated to share this information with their parents. Moreover, the availability of preventative surveillance measures to reduce the risks for LS-related cancers influenced participants who received a LS-associated variant to share the genetic information with at-risk relatives.

Methods of communicating with family. Many participants utilized phone calls as a method to initiate sharing news of their genetic test result, especially when family members did not live within close proximity to them:

> *"On the phone call because they live overseas. I had to get it from Geisinger, a genetic letter, but I didn't want to send it over there, so I made a phone call."*

As is exemplified in the previous quote, a phone call often opened the line of communication between family members prior to the patient letter. However, there were some instances in which only a phone call was described as the most practical way to share the information with relatives, such as when participants reported to have large families:

> *"I just talked to them on the phone. I have a huge family, anyway, I can't go and visit everybody, you know some of my closest uncles and stuff or my cousins yeah I'll tell them in person or whatever you know if we chose to talk about it."*

In addition to phone calls, participants often discussed using the "Dear Family" letters provided by Geisinger to communicate the genetic information with their at-risk relatives.

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"Well, initially I just kind of told them verbally, and then Geisinger sent me a packet that I could share with the kids. I made copies for my 4 kids and my sister..."

Barriers

Lack of contact or closeness. Despite the participants' perception of the importance of the result implication, they said one of the roadblocks to communicate the genetic information was the lack of contact or closeness to their family members, exemplified as follows:

"We don't talk, but I did send the information [patient letter] to my nephew… Hopefully my brother will get the information...I haven't verbally talked to anybody because they don't talk to me…"

"I actually have 3 half siblings in the United States and I don't really talk to them much…"

Young age. Participants reported a reluctance to disclose information regarding the LS-related risks associated with the genetic test result to relatives who are under the age of 18. However, some participants stated that they are planning to share this information with their family members as they get older and can make decisions pertaining to genetic screening and reproductive options:

"My oldest is 15, she kind of knows to a point. I mean she knows I have Lynch syndrome and she kind of knows what it entails but she doesn't know everything. We haven't exactly sat down to explain everything to her."

"They're [grandchildren] too young. If I'm still around...when they get old enough, I'll tell them myself."

Changes in Medical Management

Obtaining medical management and surveillance recommendations are one of the benefits of knowing about hereditary cancer risk. Most participants described being able to follow the medical recommendations related to LS as a result of several factors that facilitated their medical

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management changes. Some participants also expressed experiencing several barriers to receiving and/or implementing suggested medical care.

Facilitators

Access to and coverage by insurance. Participants said their ability to follow medical management and surveillance recommendations was facilitated by their insurance accessibility and coverage:

> *"I don't have any financial burden from that. It is all insurance covered."*

A majority of participants provided positive feedback in regards to getting their health insurance plans to cover their care related to LS. A frequent comment participants made was that there had been issues obtaining health insurance coverage for other medical issues not related to LS, and that coverage related to their LS-related cancer prevention remained unaffected.

Institutional Coordination of Care. Participants in this study reported a value having access to the IRGI clinic, or "Lynch clinic" as the participants referred to it, offered by Geisinger and outlined the care that they received:

> *"I would say that the Lynch clinic is really nice because everything is all there, rolled up into one ball there. I can get scheduled and have my urology appointment, my urinalysis, my colonoscopy, my vaginal exam, everything always in one day, as opposed to having it here, there, and everywhere."*

> *"I have never had an appointment in my life where you got the care that you did and everybody, it was like a one-stop shop, you go to the doctor appointment and everybody comes to you...I never experienced that before…"*

Moreover, the role that Geisinger genetic counseling assistants (GCAs) play in contacting individuals with an LS-associated variant who are due for their surveillance appointments was

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described by participants as facilitating their adherence to an appropriate medical management plan.

> *"Positive thing is the fact that Geisinger does have kind of a dedicated resource coordinator and one part of that is setting up those workshops, for instance, but also to follow up and follow through by that coordinator office as opposed to having to kind of drive these things on my own or with my primary care physician. I think that's made this easier. So, that was a plus."*

Healthcare professionals (HCPs) advocating for their patients. In some cases, participants described healthcare providers providing excellent patient-centered care and advocating on behalf of the participant and their at-risk family members. Of important note, this advocacy was highly valued when participants were attempting to seek cascade testing for their immediate family members, such as their children. While not a common occurrence among participants, access to familial genetic testing was facilitated by the efforts of medical professionals already involved in the patient's care:

> *"Now that I'm thinking about it, he [oncologist] gave me a genetics test too on his own because then he pushed for my daughters to have it because he didn't want to give my children it. And he had to fight tooth and nails for my girls to get it."*

Participants elaborated on the active role their Genetic Counselors played in advocating on their behalf to receive appropriate care set by the NCCN established guidelines pertaining to LS. In certain cases, participants were very well aware of the care they should be receiving, such as being scheduled for more frequent colonoscopies than those in the general population. However, they stated that they turned to their Genetic Counselor for validation, especially if they were being told conflicting information otherwise.

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"I went to my genetic counselor this year, and said he [GI] is going to see me in 3 years, they [genetic counselor] were right on it, these people help you, they advocate for you, and that we're going to refer you to somebody else because it is not right."

Close relationship with physicians. Many participants highlighted how having a close relationship with their physicians helped them feel comfortable, confident, and supported throughout their medical journeys. A majority of participants recognized the strong presence their primary care physician (PCP) played in discussing and coordinating their care, especially pertaining to LS. The willingness of the PCP's to have an open dialogue with their patients was described by participants as leading them to a renewed sense of self-motivation and validation attempting to better manage their risk for LS-related cancers.

"It's something that in my kind of normal periodic checkups he will bring that up and we'll talk about the preventative action and surveillance as he is reviewing my medical record. He asks if I have any questions or if I need any referrals or if I have any concerns. So, I think that, in my case I am very satisfied with my primary care's actions on this……. It gives me some confidence, I guess. It reinforces what I'm doing. He seems to agree with everything I'm doing and doesn't have anything else to suggest. So, I am feeling satisfaction there I guess."

Support person. Some participants stated that getting the support of a family member helped to encourage them in multiple aspects of their care related to LS, from ensuring they attend healthcare appointments to contacting health insurance companies when necessary.

"...my oldest daughter will say "Mom, I think it's time." You know? Each year, I don't miss anything, my mammograms, my colonoscopies, none of it. I make sure my daughter doesn't miss hers."

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"He [husband] was very supportive. He did anything that needed to be done. He would help me do anything that needed to be done... He has kept me on top of talking to the insurance company because he can't do that for me, and he has taken me to my appointments."

Participant's perception of their HCPs educational efforts. Participants stressed the importance of feeling like their HCPs were up-to-date on LS and the risks associated with their particular genetic difference.

"A genetic counselor/oncology team... see me together once a year to to follow up, see how I am doing, giving me new updates about Lynch Syndrome and my genetic defect variant, and what is new about it and all that stuff, if anything changed on what I should be doing."

Barriers

Alternative chief complaint. Participants with alternative medical chief complaints, whether they have been lifelong or a more recent diagnosis, tended to not prioritize LS-related care. Lifelong medical concerns included conditions such as irritable bowel syndrome or Crohn's disease, and recent diagnoses were often of cancers unassociated with LS, such as hematologic in nature. Participants emphasized that medical professionals involved in their care often did not address LS when there were other medical issues at hand.

".....My doctor and I usually have something much more active going on to talk about."

"Not doing much pertaining to Lynch syndrome at all. I was just dealing with just starting [multiple myeloma] cancer protocol."

Another priority participants described was being a caregiver for a family member. Participants did not prioritize their own medical care if they had a family member affected by a life-threatening medical condition who required consistent healthcare assistance.

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"I did my best to keep up…I shouldn't use this as an excuse, …. but the truth is that when you're taking care of somebody else and you are the caregiver, it is hard to think about yourself when you are thinking about that other person all the time...you are like the last person on the list."

COVID-19 implications. The COVID-19 pandemic has had a huge impact on several aspects of healthcare in the year 2020, especially when it came to whether or not hospital systems continued to offer elective procedures such as colonoscopies, that LS patients rely on receiving on a consistent basis. In a few interviews, some of the participants had complaints about surveillance appointments related to LS having been postponed due to the pandemic, as their surveillance schedule happened to fall during months in which the United States was experiencing country-wide shutdowns to many public establishments, including hospitals and high-risk surveillance centers.

"No challenges other than an appointment being delayed because the hospital was choosing to avoid elective or non-critical procedures, so that resulted in a couple month shift in that particular session."

HCP's limited knowledge about LS. Several participants mentioned that they were facing HCPs with limited or conflicting knowledge about LS and their management plan. As a result, participants were confused regarding their management and surveillance plans moving forward.

"At first they said you need to get a hysterectomy and then I didn't need a hysterectomy like a radical hysterectomy. I have to wait until I am at least 40 some... Some of them had different opinions than others...it seems like not everybody was on the same page with, like, as to what they were telling me."

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In addition, participants stated that they were surprised by the lack of comprehensive knowledge their HCPs had about LS. Furthermore, participants stressed that some medical professionals they saw on an annual basis would address cancer risk and cancer prevention relative to their own specialty, but would not address LS-related cancers specifically. The following participant quote addresses both sides of this sub-theme that we heard in our interviews:

> *"...that kinda surprised me. They kinda were fishing for me to give them information instead of them giving me information. It was very weird. It's like they knew what it was, but they still at the same time wanted some kind of more clarification or something about it…..Like my gynecologist. They were more like straight shooting on cancer, but not specific Lynch syndrome…."*

Lifestyle modifications

Along with medical management changes, participants discussed lifestyle modifications after being informed of their LS-associated variant as part of their preventative care. They considered making these changes after hearing their doctors discuss these options, reading about them online, or receiving advice from individuals in their communities.

Facilitators

Lifestyle modification communicated. Participants mentioned that they implemented some modifications in their lifestyle, such as following a healthy diet, avoiding red and processed meats, and/or consuming certain supplements. They said those lifestyle modifications were usually communicated and recommended by their HCPs as part of their healthcare plan.

> *"Precautions-wise, I guess as a family, we are trying to avoid cured meats is the one I think comes to mind first, things that are nitrates, salami, bacon and those sorts of things..."*

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"...but then he also gave me something, turmeric, which I do believe helped me a lot to fight the cancer. He has me on a daily fiber pill and vitamin C, immune system, immune medicine....and I truly believe it [turmeric] helped."

Overall, participants reported that they adopted behaviors that promoted a healthy lifestyle into their daily regimen. This included exercising and being cognizant of managing their weight appropriately. Participants who attended Geisinger's IRGI clinic further elaborated on the lifestyle modifications they decided to make, such as specializing their diet to include organically-grown products.

"I'm primarily, it's just with diet and weight, exercise,...."

"...the one doctor I saw through the Lynch clinic had really suggested a lot more organic foods, so we switched to a lot more organic."

Barriers

Lifestyle modifications not communicated. Although some participants stated that they made some modifications in their lifestyle after learning of their LS-associated variant, many of them had not. If participants disclosed that they did not implement any lifestyle modifications, a majority were prompted to share if they have been told about potential lifestyle modifications to consider or not. A common response participants had was, "I haven't really been told anything". Therefore, participants reported not implementing any lifestyle modification because of a lack of communication about what lifestyle modification they could follow as part of their preventative care for LS-related risks.

Discussion

The focus of this study was to investigate how individuals identified to have LS-related cancer risks through MyCode population genomic screening communicate the genetic information with

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their family members, follow medical recommendations, and lifestyle considerations. Results of this study identify the facilitators and barriers to family communication behaviors, following medical recommendations, as well as lifestyle modifications after receiving an LS-associated variant result.

Family communication about genetic information and risks is crucial to at-risk relatives to utilize the best possible genetic healthcare services. Patients with a hereditary cancer syndrome diagnosis feel responsible for sharing the genetic test result with at-risk relatives (Chivers-Seymour et al., 2010). Providing patient letters has been a common way for HCPs to facilitate family communication to ensure that genetic information is communicated accurately to initiate making an informed decision about whether to pursue a genetic test or not (Mendes et al. 2016). The availability of patient letters has increased the pressure that patients felt to communicate the genetic information with at-risk relatives; however, using a patient letter to share the risk with relatives increased patients' confidence, further helping them to fulfill their sense of duty to share (Dheensa, Lucassen, & Fenwick, 2018). Our results showed that Geisinger's equivalent to a patient letter, the "Dear Family" letter, was utilized to facilitate family communication frequently; however, it was often referenced or distributed to at-risk relatives after communication was first initiated through a personal phone call. Participants found that the letter was useful for their own benefit and allowed them to fulfill a sense of duty to alert their family members to the potential risk of having an LS-related variant.

Coordination of care was reported by participants to be one of the facilitators of following medical management guidelines for their LS-associated variant. Studies have shown that having a genetic work-up, including genetic testing and genetic counseling, has shown an increase in the uptake of recommended cancer surveillance (Stoffel et al., 2010). Per MyCode Community Health Initiative

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working protocol, MyCode participants are to be contacted by a member of the "clinical genomics team", which involves clinical geneticists, licensed genetic counselor, genetic counseling assistants, and other genetics healthcare professionals, disclosing pathogenic/likely pathogenic genetic results to them prior to seeing medical providers who will be managing their care moving forward (Williams et al., 2018). For participants who were identified to have an LS-associated variant via MyCode, incorporating the step of speaking with the clinical genomics team to facilitate a genetics evaluation and a follow-up plan simulates what has been found to be successful in other studies examining coordination of care moving forward. Assisting in appropriate follow-up management rather than simply learning of their genetic test result was a vital piece to inform them of the importance of consulting with appropriate specialists and pursuing preventative surveillance for LS-related cancers (Stoffel et al., 2010). The coordination of follow-up care on behalf of the MyCode team provides participants who receive a pathogenic/likely pathogenic with an established medical care team partnership, providing guidance in managing the increased risk for LS-related cancers.

Aspects of a healthy lifestyle are known to reduce the risk of the onset of colorectal cancer for survivors and previvors, but less information is known about the direct effect these lifestyle modifications have on the LS-associated cancers specifically (Burton, et al., 2010). Considering there is little research currently surrounding the effectiveness of these recommendations, there is still debate regarding how crucial it is for different medical providers to report on the utility of the changes, and who should assume this responsibility (Burton, et al., 2010). It has been proposed that the environment in which instructing, information-tailoring, and discussion about patient behavior was expected, such as a genetic counseling session, would be ideal to review aspects of how and which lifestyle modifications to incorporate (Burton, et al., 2010). Some participants

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shared that they found utility in discussing potential adjustments that can be made to one's lifestyle to be empowering due to the level of control they have in maintaining a healthy lifestyle, such as by what they choose to consume and how they choose to manage weight. Without having established lifestyle modification recommendations as there are with medical management recommendations, proposed lifestyle modifications are entirely up to the individuals with LS to incorporate what is best for them. This seems to provide these individuals a sense of control in an otherwise uncertain scenario with the potential risk to develop an LS-associated cancer.

Conclusion

Practice Implications

This study identified major themes related to facilitators and barriers of communicating LS genetic test results to their family, and using those results to guide their personal medical management, and lifestyle modifications. This study provides a unique perspective as it assesses what participants were willing and able to share with other family members and incorporate surveillance protocols and lifestyle modifications into their preventative health care.

Receiving LS-associated variant information indicates individuals' increased risk for certain cancers and necessitates the consideration of additional medical care to detect and prevent these cancers. This information can increase anxiety and uncertainty for individuals with LS. Negative emotions and risks can be aggravated by healthcare barriers including lack of care coordination, limited HCPs knowledge, and absence of patient-centered communication (Campbell-Salome et al., 2020; Schneider et al., 2018). Patients with LS may face many challenges to regularly follow the frequent and complex (ex. colonoscopy preparation) surveillance procedures. For participants in the current study, these potential barriers were largely overcome by institutional coordination

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of care and HCPs support, highlighting these as critical facilitators for participants to follow recommended medical management.

The utility of how an interdisciplinary approach can be used to coordinate cancer patient care was a shared sentiment among the participants who took part in Geisinger's IRGI clinics (Tremblay et. al, 2017). This care model benefits patients by providing a comprehensive approach to coordination of preventative care. Furthermore, potential barriers to care are eliminated by ensuring the medical care team is on the same page when it comes to personalized patient care related to LS recommendations. Receiving care annually through the IRGI clinic facilitates successful long term follow up and provides an example of how a healthcare organization can support continued communication with patients identified to have hereditary risk. The coordination of the IRGI clinic is also supported by both GCs and GCAs. With the role of the GCA constantly expanding (Hallquist et al., 2020), other healthcare systems could consider the model of GCA support for care coordination for individuals with hereditary cancer risk syndromes.

With the continued advancements in genetic testing technology, there is beginning to be a shift in the medical field from the "screen first, genetic/genomic testing second" method to now starting with genetic/genomic testing to identify individuals who are at a higher risk to develop additional cancer diagnoses in order to personalize recommended surveillance protocol to best personalize their care (Schwartz et al., 2018). Moreover, internal research genomic profiling of tumors at high-volume cancer centers is increasing as we continue to try to learn more about the onset of cancer (Cheng et al., 2015). In addition, clinical diagnostic laboratories are creating diagnostic testing platforms to differentiate sporadic cancers from those that were caused by having a LS-associated pathogenic/likely pathogenic variant (Gray et al., 2018). As hereditary cancer risk is increasingly identified in unselected populations, it is imperative that those individuals be supported in pursuing

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appropriate medical care and discussing the results with family members. A major theme that emerged during our analysis was that participants benefited from supportive information about the result and care coordination. This facilitated the spoken uptake in surveillance and willingness to share with family members amongst the participant group.

Limitations

A limitation of our research is that the data we collected was from 17 participant interviews who were chosen from a group of 128 total individuals stratified by biological sex, age, and the particular gene in which they received a pathogenic or likely pathogenic result in through the MyCode Community Initiative. As a result of this small sample size, we are unable to conclude if these feelings and impressions are shared amongst a larger cohort within this particular subset of individuals. To add, this study focused on the population screening scaffold of one major medical center in the United States, Geisinger. Many of the components that participants mentioned are specific to being involved in the Geisinger system, such as insurance plans, access to LS-specific clinic environments, and an integrated genomic research center that can connect them to the appropriate resources for better facilitation of their preventative management.

Reliance on patient stories and their recollection of past medical care initiatives, known family action steps regarding surveillance and pursuing genetic testing, and how past conversations went with family members when relaying the genetic test result were also a limitation of our study. Considering it may have been anywhere between 1-3 years since the results were disclosed, time may have influenced the amount of information participants shared during the interview.

The conversations with their family also more than likely occurred closer to the time of result disclosure, allowing for time and family member reaction to influence what they remember and disclosed during their interview.

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Future Directions

A potential future direction for this project would be to expand this study in a quantitative fashion, measuring what facilitators and barriers exist within this patient population. Thereafter, contacting more individuals from the MyCode patient database who received an actionable LS result or by contacting other large-scale medical centers across the United States who have similar population screening/surveillance protocols in place would allow for a more diverse data set regarding topics such as feasibility to maintain medical and lifestyle modification recommendations, the role insurance has played in their coverage of care, and compliance with advice from healthcare professionals. Also, a larger cohort of participants would provide for more patient experience stories, potentially expanding the scope of our current study to address more aspects of the healthcare system involved in preventative cancer surveillance. Considering that MyCode continues to return results to participants during the COVID-19 pandemic, it could be important to consider experiences of individuals more recently notified of an LS result. This would allow us to learn more about their experience regarding following through with preventative healthcare measures, having access to medical management resources, and communicating with their family members while adhering to strict social distancing requirements. This would involve participants having to make choices about coming into contact with HCPs in a hospital setting while trying to navigate the uncertainty of LS during the uncertainty of a pandemic.

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Appendix

Interview Questions Guide

Hello, my name is [Brooke/Reem] and I am a genetic counseling graduate student at Sarah Lawrence College. Thank you again for agreeing to participate in this study. Is now still a good time for our call?

As a reminder, your participation in this is voluntary. I expect that this interview will take between 45 minutes-1 hour and it will be voice recorded. I will not record your name and your information will remain confidential. Please be honest with your responses. You can say whatever you want- nothing will hurt my feelings and nothing you say will impact your care at Geisinger. You may choose to skip any question, just let me know you'd like to not answer it. I appreciate your willingness to help with my project. To thank you for your time, we'd like to send you a gift card via email. Can you please confirm that your email address is XXXXX?

Do you have any questions for me before we begin?

Is it okay if I start recording now?

Broad Question	Probe(s)	Main idea(s)
Thinking back to the first time you received your MyCode result pertaining to Lynch syndrome, what were your initial thoughts?	**Probe-**How have you been feeling since? **Probe-**What concerns have you had?	Document the patient's initial thoughts and feelings about their result to be used as a baseline for how they've changed over time.

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Tell me what you knew about Lynch syndrome prior to receiving your MyCode result?	**Probe-**What have you learned about Lynch syndrome after receiving your MyCode result? **Probe-**How did you learn about Lynch syndrome?	Determine patient competence regarding Lynch syndrome before and after receiving their result. Identify the information source(s) and how patient knowledge of the condition has changed over time.
What have you been doing differently regarding your healthcare choices, if anything, since receiving your MyCode results?	**1) Probe-**What did you learn from your doctor(s) and/or elsewhere? a. What recommendations have you been told or seen? b. What recommendations have you followed, if any? I. Tell me about your experience in keeping up with these recommendations?	Document how patients are incorporating medical and lifestyle recommendations in their healthcare management. Assess how the COVID-19 pandemic affected patient experience in regard to healthcare choices.

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	II. Tell me about what makes it difficult to follow these recommendations? 1. Probe-Describe what your experience has been like staying on top of these healthcare choices during the COVID-19 pandemic? **2) Probe-**How did other sources, if any, influence your past choices regarding the recommendations proposed to you? a. Who/What did influence them? b. What made you decide that that was the right choice?	Identify any external influences impacting patient healthcare choices.
What has been easy or straightforward about managing the risk for		Assess what has come easily for the patients in

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Lynch syndrome-related cancers (e.g. colorectal and small bowel [for female patients, include endometrial and ovarian])?		managing their cancer risk.
While attempting to receive care for Lynch syndrome, what, if anything, was difficult for you before the COVID-19 pandemic?	**1) Probe-**What, if any, issues did you have in getting insurance to cover your care related to Lynch syndrome? **2) Probe-**What, if any, problems did you have in talking to your doctor about Lynch syndrome? a. Can you describe this experience and how it made you feel? **3) Probe-**What, if any, problems did you have in seeing a doctor (e.g. appointment availability, proximity of specialty clinics, etc.)?	Determine multiple barriers patients could have experienced in seeking appropriate healthcare prior to the limitations encountered during the COVID-19 pandemic. Determine how patients tried to overcome these barriers. Research what patients believe should be

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	4) Probe-In thinking about these issues, how did you try to get your appropriate care? **5) Probe-**What do you think is needed to change in order for you to have received appropriate care?	adjusted in order to prevent these barriers from limiting their access to appropriate care.
Have you spoken with your family members about your diagnosis?	**1) Probe (If yes)-**Who in your family did you share this information with? a. How did you choose to communicate this genetic information with them? b. Can you describe how they responded? I. What about their reaction surprised you, if anything? II. Who, if anyone, sought out medical services? Specifically, genetic testing?	Identify how genetic information is being communicated and received within the patient's family and with whom (1st/2nd degree relatives). Determine who in the patient's family decided to seek medical services and their process in doing so.

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	1. What has been the outcome of this relative doing this, pertaining to their medical care? (e.g. health choices, diagnosis, etc.) 2. What has been the outcome of this relative doing this, pertaining to existing relationships and personal emotions? c. How did you feel sharing that information with them? **2) Probe (If no)-**Tell me what is preventing you from sharing it with your family? a. How does that make you feel?	Identify the healthcare and emotional outcomes that resulted from the family member(s) seeking medical care and how the patient feels about their decision to share. Identify the barriers that are interfering with the patient's comfortability for communicating the genetic information within their family and what support they would need to do so.

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	b. What support do you think would help you share this with family?	

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