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ATTITUDES AND PRACTICES OF GENETIC COUNSELORS IN PROVIDING PREDICTIVE TESTING TO MINORS AT RISK FOR LI- FRAUMENI SYNDROME

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**ATTITUDES AND PRACTICES OF GENETIC COUNSELORS IN PROVIDING
PREDICTIVE TESTING TO MINORS AT RISK FOR LI-FRAUMENI SYNDROME**

A

THESIS

Presented to the Faculty of
The University of Texas
Health Science Center at Houston
and
The University of Texas
MD Anderson Cancer Center
Graduate School of Biomedical Sciences
in Partial Fulfillment of the Requirements

for the Degree of

MASTER OF SCIENCE

by

Allison Copeland, B.S.
Houston, Texas

May 2013

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**ATTITUDES AND PRACTICES OF GENETIC COUNSELORS IN PROVIDING
PREDICTIVE TESTING TO MINORS AT RISK FOR LI-FRAUMENI SYNDROME**

Publication No. _____*

Allison Copeland, B.S.

Supervisory Professor: Louise Strong, MD

Li- Fraumeni Syndrome (LFS) is a rare autosomal dominant hereditary cancer syndrome caused by mutations in the *TP53* gene that predisposes individuals to a wide variety of cancers, including breast cancer, soft tissue sarcomas, osteosarcomas, brain tumors, and adrenocortical carcinomas. Individuals found to carry germline mutations in *TP53* have a 90% lifetime cancer risk, with a 20% chance to develop cancer under the age of 20. Despite the significant risk of childhood cancer, predictive testing for unaffected minors at risk for LFS historically has not been recommended, largely due to the lack of available and effective screening for the types of cancers involved. A recently developed screening protocol suggests an advantage to identifying and screening children at risk for LFS and we therefore hypothesized that this alongside with the availability of new screening modalities may substantiate a shift in recommendations for predictive genetic testing in minors at risk for LFS. We aimed to describe current screening recommendations that genetic counselors provide to this population as well as explore factors that may have influenced genetic counselors attitude and practice in regards to this issue. An online survey was emailed to members of the National Society of Genetic Counselors (NSGC) and the Canadian Association of Genetic Counsellors (CAGC). Of an estimated 1000 eligible participants, 172 completed surveys that were analyzed. Genetic counselors in this study were more likely to

support predictive genetic testing for this population as the minor aged ($p < 0.05$). This trend was influenced by the individual requesting testing, the presence of a family history of LFS-related childhood onset cancers, and the availability of appropriate risk management ($p < 0.05$). Counselors were knowledgeable regarding recent screening measures which may be helpful in directing physicians towards new options. When discussing their attitudes towards predictive testing, genetic counselors considered many factors and raised both the opportunity for benefit and harm, while also addressing the gap in knowledge on this subject. These findings indicate the relevance of continued discussion on the appropriateness of predictive genetic testing in this population and the importance of continued research and education to develop future guidelines.

Table of Contents

Acknowledgements	iv
Abstract	v
List of Illustrations	viii
List of Tables	ix
Introduction.....	1
Methods	2
Participants and Recruitment	2
Measures	2
Data Analysis	3
Results	3
Demographics	3
Attitudes	5
Screening Recommendations	8
Changes in Attitudes and Recommendations	10
Open Ended	11
Discussion	14
Attitudes	14
Screening Recommendations	15
Factors Influencing Attitudes and Recommendations	16
Limitations	17
Future Directions	17
Conclusion	17
Bibliography	19
Vita	21

List of Illustrations

Figure 1: Responses to Attitude Questions.....	7
Figure 2: Screening recommendations for minors with positive <i>TP53</i> mutations at each age range	9
Figure 3: Changes in attitudes and recommendations by counselor experience...	10
Figure 4: Factors influencing change in counselor attitudes and recommendations.....	11

List of Tables

Table 1: Demographic characteristics of respondents 4

Introduction:

Li- Fraumeni Syndrome (LFS) is a rare autosomal dominant hereditary cancer syndrome caused by germline mutations in the *TP53* gene.¹ Individuals with LFS are predisposed to a wide variety of cancers. However, core cancers include breast cancer, soft tissue sarcomas, osteosarcomas, brain tumors, and adrenocortical carcinomas.²⁻³

An individual carrying a mutation in the *TP53* gene has up to a 90% lifetime cancer risk, with 20% of the carriers developing a first cancer under the age of 20.⁴ To determine which individuals in a LFS family are at this significant risk for cancer, predictive genetic testing is clinically available. However, such testing for minors (less than 18 years of age) presents unique challenges for genetic testing guidelines. The American Society of Human Genetics recommends that timely medical benefits and psychosocial benefits be used as primary justifications for genetic testing in a minor.⁶ Historically, predictive testing has been discouraged in minors at risk for adult- onset conditions, such as Hereditary Breast and Ovarian Cancer syndrome, as there is are no immediate medical or screening benefit.⁷⁻⁹ However, predictive genetic testing in minors is recommended for conditions such as Familial Adenomatous Polyposis, as there is a significant childhood cancer risk and test results alter screening and management recommendations.⁹⁻¹⁰ Predictive testing guidelines for minors at risk for LFS are not as clearly defined. Despite the significant risk for childhood cancer, the variety of cancer types and absence of effective screening techniques have created controversy in justifying predictive testing for minors.^{7, 11}

Currently, testing and screening guidelines from the National Comprehensive Cancer Network (NCCN) are targeted mostly to adult onset cancers associated with LFS and give little direction for children.¹² However, a recent publication by Villani et al, (2011), suggests screening measures, including annual rapid total body MRI, to reduce mortality in children with LFS.¹³ The availability of screening modalities, and the potential benefits may alter recommendations for predictive testing in minors at risk for LFS.

The objective of this study was to evaluate genetic counselors' attitudes towards and practices in providing predictive genetic testing and screening recommendations to unaffected minors at risk for LFS in the United States and Canada. In addition, this study evaluated factors influenced past and current recommendations for genetic testing and high risk screening.

Methods:

Participants and Recruitment

This study was approved by the Institutional Review Boards at both the MD Anderson Cancer Center and the University of Texas Health Sciences Center at Houston. Approximately 2600 genetic counselors in the United States and Canada through the National Society of Genetic Counselors (NSGC) and the Canadian Association of Genetic Counsellors (CAGC) to participate in this study through an electronic questionnaire via SurveyMonkey (<http://www.surveymonkey.com/>). Members of these societies received an initial email invitation that included a link to the study, followed by a reminder email. Counselors were eligible to participate if they self-reported as having past or present cancer counseling experience. An estimated 1000 genetic counselors were eligible for this study. Questionnaires were administered between November 5, 2012 and January 29, 2013. One hundred and seventy-two questionnaires were completed and included in the analysis.

Measures

The study questionnaire was developed by the authors and was designed to assess genetic counselor's attitudes and practices towards predictive genetic testing for asymptomatic minors (defined as those younger than age 18) and their screening recommendations upon a positive genetic test result. The questionnaire assessed 5 main topics: demographics, attitudes towards predictive testing for asymptomatic minors, hypothetical or actual practices in regard to LFS screening recommendations, and changes in attitudes and recommendations over time. The demographic section questions were adapted from the NSGC's Professional Status Survey (2012.)

Demographics were collected for each counselor, including their experience with cases involving minors at risk for LFS. The next section assessed respondents' attitudes toward testing in several scenarios that varied by the individuals who requested testing (i.e., parent, minor, physician), by the family history of LFS-related cancers with childhood onset, and by the availability of screening options. Responses were given on a 4-point Likert-scale (1=very unlikely to 5=very likely) for each of the following age ranges of the minor in each scenario: <2 years old, 2-5 years old, 6-10 years old, 11-15 years old, and 16-18 years old.

Respondents were asked whether they had provided counseling to or on behalf of a minor with a positive genetic test result for LFS; if so, they were asked which screening measures they had recommended based on the minor's age ("Actual Recommendations"). For those who had not provided counseling to or on behalf of a minor who tested positive for LFS, they were asked to indicate what screening measures they would recommend based on the age of the minor ("Hypothetical Recommendations").

Counselors were also asked to self-report whether their attitude towards offering LFS predictive genetic testing and screening recommendations for minors had changed over their career. In addition, they were asked to identify factors that have influenced changes in their attitudes and recommendations.

The questionnaire also included open-ended questions that solicited free-text responses regarding barriers to and potential benefits of providing predictive testing for minors at risk of LFS, as well as potential psychological harms of testing minors. Comment boxes were included throughout the survey to allow respondents to elaborate on responses throughout the questionnaire.

Data Analysis

Descriptive statistics were computed for the demographic data. For each of the attitude scenarios, a Mann-Whitney-Wilcoxon rank test was used to analyze for trends. Further trends in attitudes were analyzed separately after stratification by country, region, years since graduation, and experience with cases involving minors at risk for LFS. The screening recommendation questions were analyzed based on actual and hypothetical perspectives. Data collected from the open-ended questions were analyzed for common themes.

Results:

Demographics

Demographic and clinical experience data are summarized in Table 1. Among the respondents who provided information regarding their practice, most of the counselors are from the US and practice in a University or Non-University-Affiliated Medical Center (89% and 93% respectively). Approximately half of the counselors graduated within the past 5 years and the majority reported that they counsel primarily cancer cases. The majority

reported having had experience discussing LFS with adult patients while only about half have experience with cases involving minors at risk for LFS. Only 20% reported having had experience counseling cases involving minors with a positive *TP53* mutation.

Table 1. Demographic characteristics of respondents

	n (%)
Country (n=132, not answered= 40)	
US	117 (89)
Canada	15 (11)
Practice setting (n=149, not answered= 23)	
University Affiliated Medical Center	76 (51)
Non-University Affiliated Medical Center	63 (42)
Diagnostic Laboratory	3 (2)
Physician Private Practice	2 (1)
Other	5 (3)
Years Since Graduation from Genetic Counseling Program (n=128, not answered=49)	
5 years or less	67 (52)
> 5 years	61 (48)
Years of Cancer Counseling Experience (n=128, not answered=49)	
1-5 years	78 (61)
6-10 years	27 (21)
11-15 years	12 (9)
16-20 years	8 (6)
21-25 years	3 (2)
Percent of Current Practice that is Cancer Counseling (n=130, not answered= 42)	
0%	10 (8)
1-25%	17 (13)
26-50%	11 (9)
51-75%	10 (8)
76-100%	82 (63)

Experience Counseling Cancer Cases Involving LFS (n=172)	
Never Counseled about LFS	12 (7)
<5 cases	57 (33)
5 or more cases	103 (60)
Experience Discussing Predictive Genetic Testing With Minor at Risk for LFS (n= 170, not answered= 2)	
Never Discussed	88 (52)
<5 cases	68 (40)
5 or more cases	14 (8)
Experience Counseling a Minor with a Positive <i>TP53</i> Mutation (n= 146, not answered= 26)	
Yes	30 (20)
No	116 (80)

Attitudes

In all of the scenarios given, genetic counselors were more likely to support predictive genetic testing as the minor's age increased ($p < 0.05$). A sample of counselors' attitudes towards testing can be seen in Figure 1.

The first section of scenarios differed by the individual requesting testing. In each age range, 97-109 (68%-76%) counselors showed no change in their likelihood to support genetic testing for a minor when a parent desired testing compared to when a physician involved on the case desired testing. Of the counselors who were influenced by the requesting individual, they were more likely to be supportive of testing when it aligned with parental desires than physician desires ($p < 0.05$). Respondents were also significantly more likely to support genetic testing when a parent desired testing than when the minor desired testing up to age 15 for the minor ($p < 0.05$). This difference in support was not statistically significant ($p = .2124$) at the oldest age range, 16-18 years old, indicating that as the minor aged, counselors were similarly influenced in their attitude towards testing by parents and minors.

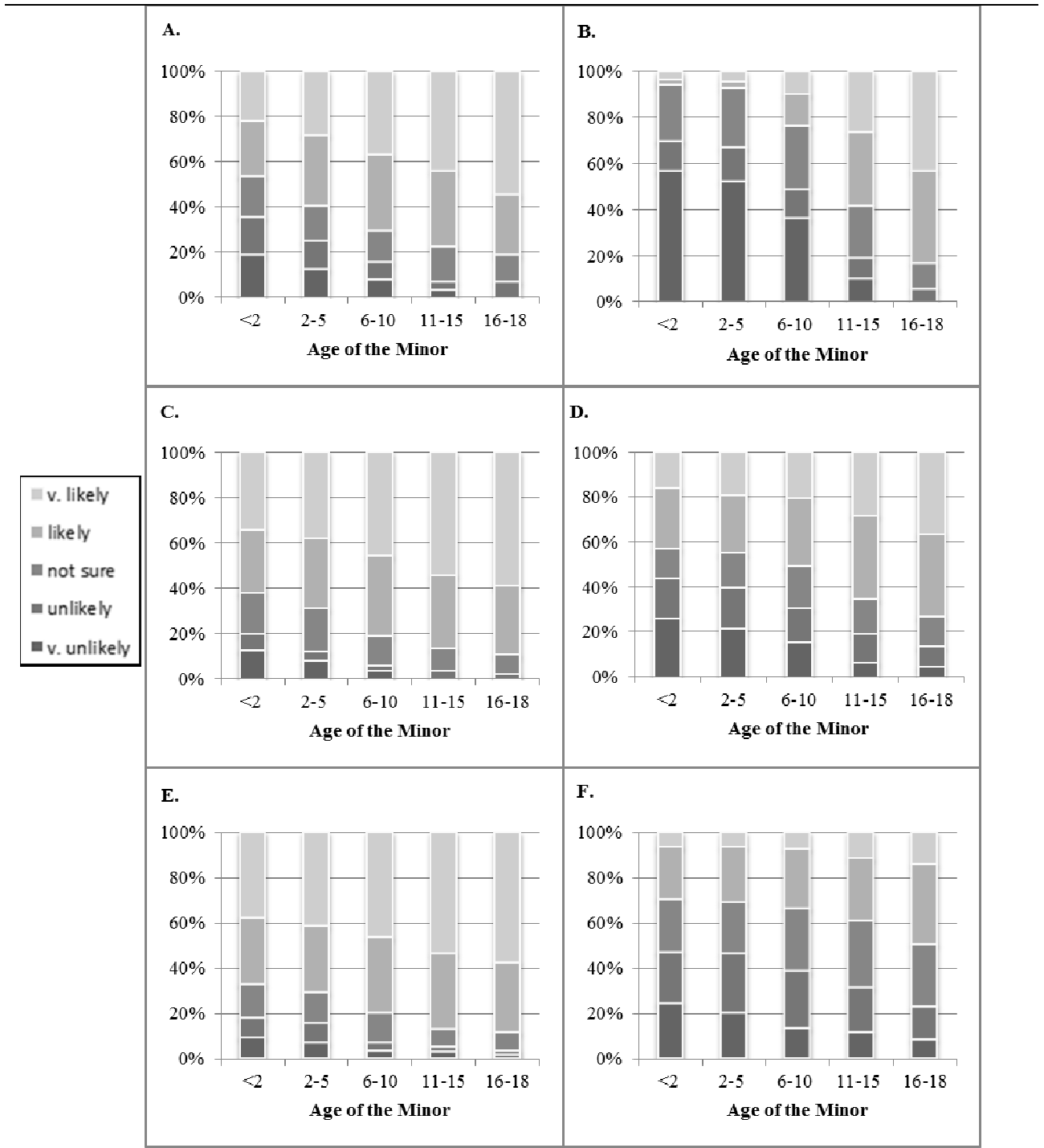
When comparing scenarios where a family history of LFS-related childhood onset cancer(s) is or is not present, between 61 and 90 (43% and 63%) genetic counselors had the

same likelihood of supporting testing within an age group for both scenarios. However, among the counselors who were influenced by family history, they were more likely to support testing in the presence of a family history of such cancers ($p < 0.05$).

The availability of risk management was a major variable in determining attitudes towards testing, with 101-109 (72%-78%) counselors changing their likelihood to support predictive testing based on this factor. These counselors were more likely to support predictive testing when appropriate risk management would be available and accessible than when it would be difficult for the minor to access ($p < 0.05$).

Of note, we analyzed the data for trends by the country or region in which the genetic counselors currently practice, and counseling experience, however, no significant trends were found across all scenarios and age ranges (data not shown.)

Figure 1: Responses to Attitude Questions



Legend Figure 1:

How likely would you be to support predictive genetic testing of an unaffected minor at risk for LFS in the following scenarios?

- A. The parents of a minor desired testing when the minor is:
 - B. A minor desired testing when the minor is:
 - C. A minor had a family history of childhood onset of LFS-related cancer(s) when the minor is:
 - D. A minor did not have a family history of childhood onset of LFS-related cancer(s) when the minor is:
 - E. Appropriate risk management would be available and accessible if the minor tested positive for a *TP53* mutation when the minor is:
 - F. Appropriate risk management would be difficult for the minor to access if he/she tested positive for a *TP53* mutation when the minor is:
-

Screening Recommendations

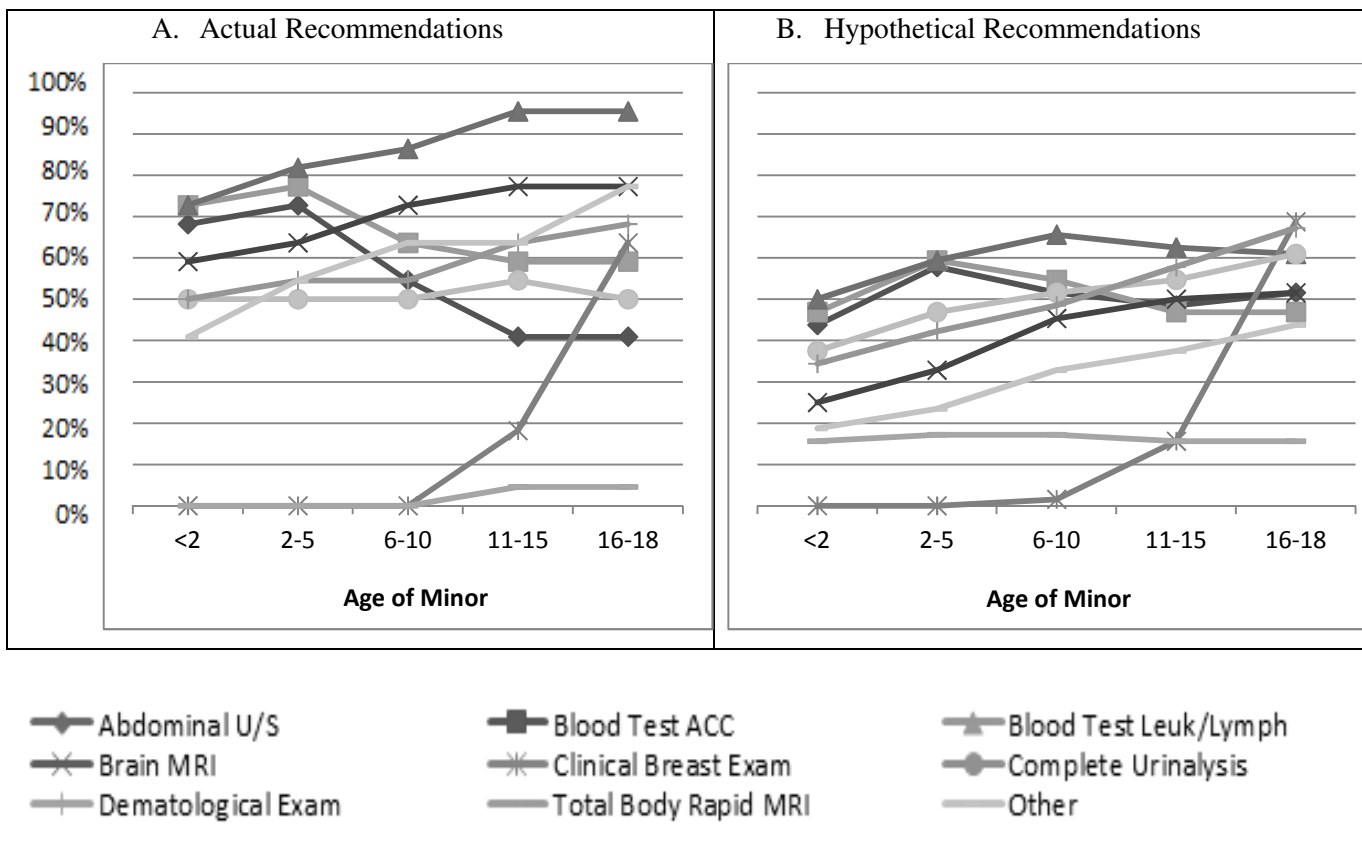
The questions regarding screening recommendations were split into two groups based on the “Actual Recommendations” and the “Hypothetical Recommendations.” Both sets of respondents were asked to identify their sources for screening recommendations. The NCCN (2012) guidelines were the most frequently cited source in both groups; however, counselors who answered from a hypothetical standpoint were significantly more likely to use NCCN (2012) than those who answered from actual experience ($p < 0.05$). Counselors who had provided screening recommendations were more likely to report that their institution had developed guidelines to use as compared to those without experience providing screening recommendations ($p < 0.05$). Eighteen (60%) of counselors in the “Actual Recommendations” group and 62 (53%) in the “Hypothetical Recommendations” group reported the protocol published by Villani et al, (2011)¹³ as a source for recommendation guidelines. Other reported sources for screening guidelines included GeneReviews, NIH studies, and protocols tailored to family history.

Of the 30 counselors in the “Actual Recommendations” group, 22 answered a question designed to determine what screening measures they recommend at different age

ranges. The “Hypothetical Recommendations” group was given a similar question asking what they would recommend at each age range if in a situation to provide recommendations. Sixty-four of the 116 counselors in this group answered the question. The recommendations from both groups can be seen in Figure 2.

In general, the counselors in the “Actual Recommendations” group were more likely to recommend screening measures for each age than the counselors in the “Hypothetical Recommendations” group. The exceptions to this trend include recommendations for abdominal ultrasound at the two oldest age ranges and the complete urinalysis for ages 6 -18 years. In addition, counselors answering from the hypothetical standpoint were more likely to choose “Other” screening recommendations. Examples of other recommendations include physical exam, PET scans, AFP blood levels, upper endoscopies, and neurological exams. The trends in both groups were similar, with the number of genetic counselors recommending screening measures increasing as the minor ages.

Figure 2. Screening recommendations for minors with positive *TP53* mutations at each age range

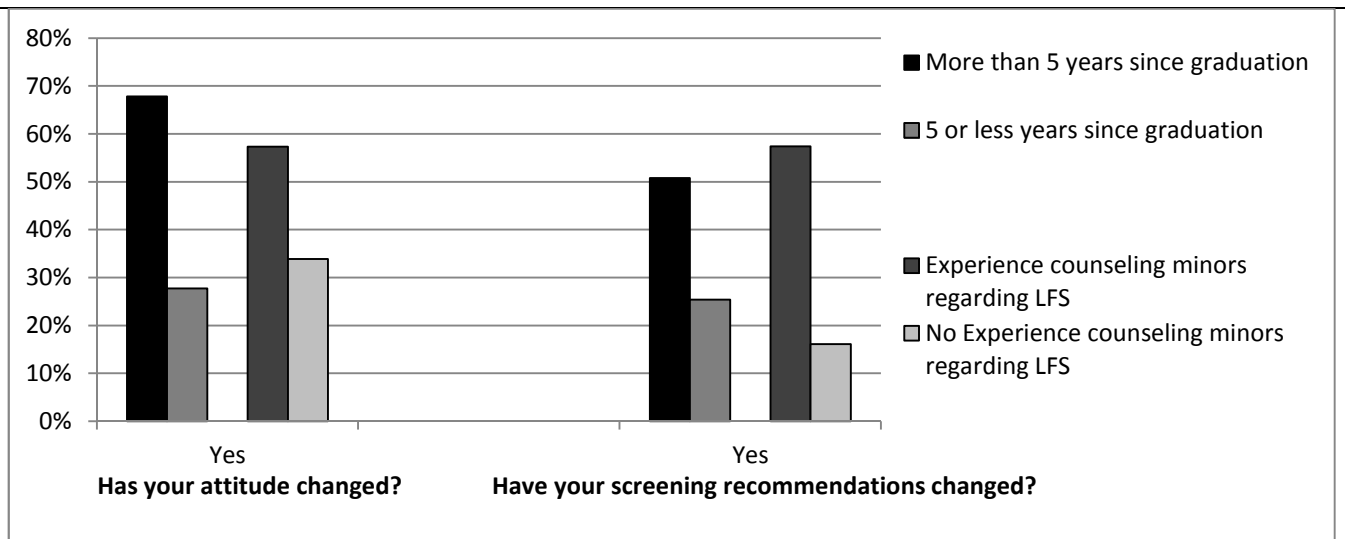


Changes in Attitudes and Recommendations

Respondents were asked whether their attitude towards predictive genetic testing for minors at risk for LFS had changed over their careers. Approximately half (53%) of the counselors responded that there has been no change in their attitude, while the other half said they are now more likely to support predictive genetic testing for minors at risk for LFS than earlier in their career. Only 2 individuals (2%) stated that they are now less likely to support testing than earlier in their career. When asked if their screening recommendations had changed over their career, 37% of individuals answered “Yes.” The remaining respondents were split between “No” and “Not Applicable” (23% and 40% respectively.)

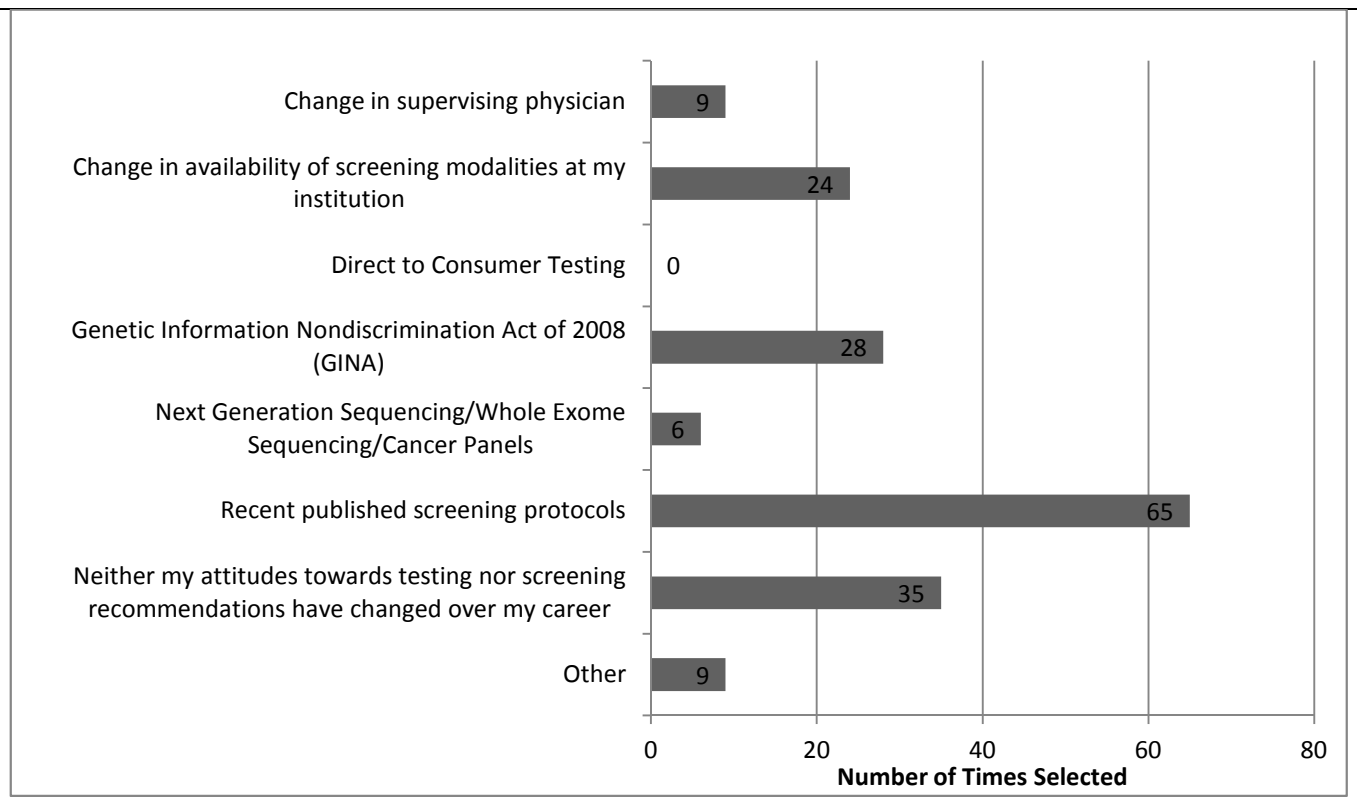
Both questions regarding changes in attitudes towards predictive testing and screening recommendations were stratified by years since graduation from a genetic counseling program and experience counseling cases involving minors at risk for LFS. Counselors who graduated more than 5 years ago, as well as counselors with experience counseling these cases, more frequently chose that they are now more likely to support genetic testing in these scenarios and that their screening recommendations have changed over their career compared to those who graduated in the past 5 years and counselors with no experience (p<0.05), which can be seen in Figure 3.

Figure 3: Changes in attitudes and recommendations by counselor experience



Respondents were also asked to identify factors that have influenced a change in their attitude towards testing or their screening recommendations, which is displayed in Figure 4. Of the 115 respondents, 65 (57%) selected “Recent published screening protocols” as a factor that influenced their attitudes and recommendations. Many counselors also chose “Change in availability of screening modalities at my institution” and “Genetic Information Nondiscrimination Act of 2008 (GINA,)” (21% and 24%, respectively.) Other factors indicated included “Patient Experience/Interaction with LFS Families,” “Continued Education about LFS,” and “Change in attitude towards testing in minors for any condition.”

Figure 4: Factors influencing change in counselor attitudes and recommendations



Open-Ended Questions

The first open-ended question asked the counselors to describe what they perceive as barriers to providing predictive genetic testing for minors at risk for LFS. Sixty-three individuals responded. Three major themes were identified: 1) Follow-up Concerns, 2) Psychosocial Concerns and 3) Knowledge Concerns.

Many counselors expressed concerns about the follow-up from genetic testing if the minor were to test positive. Examples of these concerns included availability and access to screening measures, and the burden of the surveillance regimen. One individual responded, "...I worry about access to different screening modalities and the frequency with which we would consider screening- would the family comply?..." Respondents also reported that difficulties with future insurance coverage or concerns about insurance discrimination can be barriers to genetic testing in these scenarios.

The second most common theme was psychosocial concerns for the minor and/or their parents. Many counselors mentioned the continued uncertainty of if/when the individual would develop cancer, and what type of cancer after a positive genetic test result. This theme also included responses regarding concerns about the lack of maturity and understanding in minors facing testing decisions. Several counselors also mentioned that a potential barrier is the parents who are unwilling to involve the minor in the decision, or unwilling to inform them of their results.

The heightened anxiety of the family when the possibility of LFS is brought up, especially if it is at the same time as a cancer diagnosis in the family. Not a good time for genetic counseling. The fact that we still can't predict which type of cancer, how many cancers, or when they will develop. Still much uncertainly even with a positive result...

Counselors also stated that limited knowledge and poor education on the subject of LFS for patients and physicians results in a lack of appropriate referrals, which is a barrier in obtaining genetic testing for individuals. They expressed concerns that there is no clear consensus on what age to begin offering genetic testing for LFS and what screening to recommend after a positive result. In addition, many cited concerns that there is limited data on the effectiveness of current screening measures.

...This is also a relatively new field of study, so though the results of the screening regime in the Villani study were promising, I feel like it may be too soon to tell whether these techniques are as good as they seem. We also are just learning about how widely the penetrance of LFS varies- how do we know that such intensive screening is warranted [sic] in every at-risk minor, and what about negative consequences of screening?

The purpose of the second open-ended question was to determine if genetic counselors perceive a medical benefit from predictive genetic testing in this population. Eighty-four counselors responded to this question and 71 (85%) reported that they do

believe there is a medical benefit from providing predictive genetic testing to this population. The remaining 13 individuals reported that they either do not believe there is a medical benefit, that they are not sure, or that it is a case-by-case basis. Many counselors explained their perceived benefits from testing and common answers included that testing allows for increased attention to signs of cancer and increased screening. Some counselors stated that a benefit is the potential to reduce mortality/morbidity in these minors, although many of them mentioned that this benefit is not proven.

Yes, even if there are no clear guidelines for screening, I think the mutation result causes the managing physicians to look more closely and promote more aggressive followup of any suspicious findings.

In addition to the potential benefits for minors who test positive, many respondents commented on the benefit of sparing those who test negative from rigorous cancer screening protocols.

Yes. Cancers may be caught at an early stage, maximizing treatment options, by determining who is at risk. Likewise, if they are not at risk, cumbersome medical management recommendations can be avoided.

In the third open-ended question, the genetic counselors were asked to describe their thoughts on potential psychological harm from predictive genetic testing for minors at risk for LFS. Of the 83 responders, 64 (77%) stated that they believe there is the potential for psychological harm. The remaining 19 counselors reported that they either do not believe there is potential psychological harm or that it depends on the scenario. Only 18 of the responses included examples of the potential harms. These included concerns that genetic test results may define the minor throughout their childhood, or lifetime. Counselors also mentioned concern for increased anxiety for both parents and the minor, especially in a setting that many of these minors may have a past or current family history of cancer.

I definitely believe that there is the potential for psychological harm in predictive testing of this condition for a minor. The child has typically experienced a lot of pain in their experiences with affected family members in their lifetime, and that is typically their understanding of the condition. If found to be positive, there would be the potential that they would define themselves as the condition and have a more fatalistic approach to life.

The majority of responses to this question had other comments rather than examples of specific harms from testing. Other themes in these responses included the statement that

appropriate counseling and education for the minor and their family can decrease potential harm, while inappropriate counseling increases the chances of psychological harm. Counselors also commented that there is always the potential for psychological harm when providing genetic testing to minors for any condition, but the benefits may outweigh the potential harm in some cases. Many responses also pointed out that there can be significant psychological harm in not providing genetic testing to these minors.

There is always potential psychological harm when you confirm a hereditary cancer condition in an individual. This extends to minors too. However, the benefits of knowing the information (via early detection or prevention) can outweigh the psychological risks. I am not sure if we are at this point yet due to issues with obtaining insurance coverage for some of the proposed screenings. Also it is important to weigh the psychological risks of a child not knowing-this is much more relevant for the adolescents and young adults-but for some, it will be more harmful to not know if they are at risk or not.

Discussion:

LFS is a cancer-predisposition syndrome that stands out from others. It does not fit into the category of exclusively adult onset cancers, such as HBOC, and yet there are no proven effective screening methods for at-risk children, as in FAP. Historically, this ambiguity has led to controversy over the appropriateness of testing minors at risk for LFS. Some have recommended against testing, while others caution strongly that the risks and benefits should be weighed in each case.^{11,14} As genetic counselors are often placed in a unique and important role in the genetic testing process for patients, their attitudes are important to describe. The results of this study provide a snapshot of their current attitudes towards testing for minors at risk for LFS.

Attitudes

Based on the findings from this study, genetic counselors attitudes towards predictive testing were influenced by many factors. Age of the minor proved to be a significant variable, as genetic counselors were more likely to support genetic testing in older individuals in all given scenarios. Counselors in this study recommended that the maturity and understanding of the minor be taken into consideration so it is not surprising to this trend with age. A previous study by Mackoff, et al. (2009) found that a majority of genetic counselors supported the parent or legal guardian as the most appropriate individual to make decisions regarding genetic susceptibility testing in minors.¹⁵ A similar observation

was made in this study where counselors were more likely to support genetic testing when the parent, rather than the physician or minor, requested testing.

Many counselors attitudes were not influenced by the presence or absence of LFS-related childhood onset cancers, however, those who were had more positive attitudes when there was a family history. As LFS has a wide variability in types of cancer and age of onset, family history is typically not used to predict the presentation of cancer in individuals.⁴ Therefore, this trend may be due to parental influence and anxiety, rather than medical knowledge.

Availability of risk management proved to be a major factor in genetic counselors' attitudes, with the majority of counselors having a more positive attitude toward testing when appropriate risk management would be available as opposed to when it would be difficult to access. This finding is not surprising, as risk management and medical benefit is a factor that has often been proposed as a major consideration in the genetic testing decision for minors.^{6,16}

Screening Recommendations

The results from this study indicate that genetic counselors are knowledgeable concerning current screening guidelines for LFS. While many acknowledged that there is no general consensus on screening recommendations, they were aware of new advances and had considered them in their own recommendations. Counselors who have previously provided recommendations to minors with LFS were more likely to be aware of their own institution- developed guidelines. This finding may be influenced by the fact that the counselors with LFS experience may work in institutions that see more of these cases, and therefore may have a greater need to develop guidelines.

It is important to note that the responsibility of providing screening recommendations should lie with the physicians involved in the patient's care; however, this study reveals that genetic counselors cite lack of knowledge about LFS in physicians as a barrier to genetic testing. Counselors should use their knowledge of recent guidelines to educate and work with the physicians in order to provide appropriate care for the patient.

Factors Influencing Attitudes and Recommendations

Throughout the study, genetic counselors considered both medical and psychosocial factors in describing their attitudes towards genetic testing in minors at risk for LFS. The majority of counselors considered there to be medical benefit from testing and implementing screening measures. They considered the Villani (2011) screening protocol to be a factor in positively influencing their attitudes and cited it as a resource for recommendations. An article published in France studying oncologists' views towards predictive testing for LFS provides a similar outlook. The authors argue that despite a national recommendation against such testing, recent screening advances may provide a reason for shifting attitudes.¹¹ Interestingly, although many counselors view the Villani (2011) study as holding promise of providing medical benefit, they still do not consider it a proven benefit.

Many of the other issues mentioned by counselors in this study have been raised in other studies, including thoughtfulness on the potential for insurance discrimination and psychological harm.^{15,16} While approximately a quarter of the respondents identified GINA as a factor in changing their attitudes, many counselors also stated that despite the health insurance protection it provides, they still view insurance concerns as a barrier to providing genetic testing. The majority of the counselors in this study believe there is potential for psychological harm; however, it is interesting to note that they state these harms can be at least partially alleviated by appropriate counseling. This is in alignment with recommendations from NSGC that counseling be provided before genetic testing is pursued.¹⁷ Genetic counselors should participate in counseling for both the parents and the minor to assure that these aspects of the genetic counseling process are explored.

Approximately half (53%) of the genetic counselors stated that their attitude toward testing has changed over their career, and 37% stated the same for their screening recommendations. This leaves a considerable amount of respondents that do not consider their attitudes and recommendations to have changed over their careers. There are several considerations that may have influenced this finding. Two of the factors identified by the other respondents, "Recent published screening protocols" and "Genetic Information Nondiscrimination Act of 2008 (GINA,)" are ones with substantial developments in the past 5 years. About half (52%) of the counselors reported that they had obtained their graduate degree no more than 5 years prior to this study and these recent graduates significantly less

likely to report that their attitudes have changed over their career compared to earlier graduates. The relatively new nature of the recent graduates' careers may not have provided the need or time to change attitudes in response to these advances.

In addition, only a fifth (20%) of the respondents reported that they have experience counseling a minor with a positive *TP53* mutation. The counselors without experience counseling minors at risk for LFS were less likely to have changed their screening recommendations over their career, possibly due to the fact that they have not previously provided screening recommendations to minors with LFS.

Limitations

As is common in voluntary surveys of the kind used in this study, it is possible that a self-selection bias may have arisen, where genetic counselors interested in the topic may be more likely to respond. In addition, any counselors who are not members of NSGC or CAGC were not contacted for participation. The survey was created by the authors and was not a validated tool. The data used was based on genetic counselors' self-report and the attitudes described may not be generalizable to other individuals integral to the genetic testing process, such as the minor, parents of minors, and physicians.

Future directions

Future research is needed to provide evidence for medical benefit from providing predictive genetic testing and screening measures to children at risk for LFS-related cancers. In addition, more education for patients and physicians may limit potential barriers to providing genetic testing when appropriate.

Additional research may also seek to understand attitudes of other healthcare professionals, as well as the families involved in genetic testing for minors at risk for LFS. In addition, research should continue to explore the relationship between attitudes towards testing and actual practice of providing testing to this population.

Conclusion

The conversation of predictive testing in minors for genetic conditions is not new, and there is debate particularly over the suitability of testing for adult-onset conditions.⁹ LFS, while not causing exclusively adult-onset cancers, offers its own unique challenges to the debate. Due to the lack of medical management, testing in asymptomatic minors for this

condition historically has not been recommended. By describing the attitudes of genetic counselors on this subject, our study has revealed that in response to many recent developments in the healthcare field, genetic counselors' attitudes are evolving. Research should continue to explore evidence for effective medical screening and management of LFS in minors in order to substantiate further shifts in attitudes towards predictive testing.

Genetic counselors play an important role in educating both patients and other healthcare professionals about the risks and benefits of such testing. Given the continual developments in the LFS field, counselors will need to participate in the process of developing guidelines for appropriate testing in this population.

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