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Integrating Next Generation Sequencing into Pediatric Oncology Practice: An Assessment of Physician Confidence and Understanding of Clinical Genomics

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Abstract

Background—The incorporation of genomic testing to identify targetable somatic alterations and predisposing germline mutations into the clinical setting is becoming increasingly more common. Despite its potential utility, physician confidence in understanding and applying genomic testing remains unclear, particularly in the realm of pediatric oncology.

Methods—Before initiating an institutional feasibility study on the integration of clinical genomic testing, we surveyed pediatric oncologists regarding their confidence around understanding of genomic testing, perceived utility of test results, preferences around germline results disclosure, and possible risks and benefits of testing.

Results—Among survey respondents (52 of 88; response rate 59%), only a minority were confident in interpreting, utilizing, and discussing somatic (35%) or germline (27%) genomic test results. Providers confident in interpreting somatic results were significantly more likely to anticipate using the results to plan the treatment of refractory cancers ($p = 0.009$). Similarly, providers who reported confidence in interpreting germline results were significantly more likely to discuss and utilize these results as part of clinical care ($p < 0.0001$, respectively). The majority

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of physicians (93%), regardless of their levels of confidence, wanted to speak to a genetic counselor prior to disclosing germline results.

Conclusions—Among physicians at a comprehensive pediatric cancer center, confidence in the interpretation, utilization, and discussion of oncology-based genomic results is low, both in terms of somatic and germline testing. To optimize the integration of genomic sequencing into cancer care, methods must be developed to improve basic competencies around cancer-based genomic testing. Given the complexities surrounding variant interpretation and genotype-phenotype relationships, interdisciplinary collaborations are warranted.

Keywords

cancer genomics; clinical genomics; pediatric oncology; provider confidence

Next generation sequencing approaches, including whole exome, whole genome and RNA sequencing, have revolutionized our ability to analyze the genetic make-up of tumor and normal tissues. It is now possible to interrogate massive amounts of genetic information at the point of testing and use this information to guide treatment decisions.[1] Although the knowledge gained from genomic sequencing has increased our understanding of disease development and treatment response, many questions remain unanswered as how best to integrate this technology into actual practice.[2–6]

Currently, the scientific understanding of genotype-phenotype correlations and the predictive value of genomic data remain unclear.[7] The uncertainty that often surrounds the interpretation and utility of sequencing data creates challenges for health care providers as they incorporate clinical genome and exome sequencing (CGES) into patient management. Several of these challenges include: 1) understanding and interpreting CGES results; 2) determining when and if findings should be used in clinical care; and 3) developing meaningful ways to communicate genomic findings and associated information to patients and their families.[8] These challenges are of particular importance in oncology where precision medicine and use of targeted therapies are a major research and clinical focus. Towards this end, CGES analysis of tumor tissue is becoming increasingly common in the management of cancer as oncologists look for specific driver mutations or altered signaling pathways that are amenable to targeted therapy.[9] Given emerging data on the beneficial effects of cancer surveillance and risk reducing measures, there is also interest in utilizing germline CGES to detect underlying cancer susceptibility syndromes.[10]

Genomic Sequencing is a complex technology that rapidly transitioned from research-only use to application in the clinical setting. Nonetheless, few data exist, particularly in pediatric oncology, to describe whether and how providers: 1) understand the information generated through CGES; 2) utilize CGES in patient management; 3) communicate with patients about their results.

Current literature shows low levels of provider confidence in interpreting and applying results generated from focused genetic testing for mutations associated with disease risk (e.g. cancer predisposition).[11–15] In a 1999 survey of 1,251 United States physicians only 29% reported confidence in counseling patients about cancer susceptibility testing, although

the confidence rate was somewhat higher among oncologists (50%).[12] Reasons cited for the lack of confidence were numerous, but included uncertainty about the availability of genetic testing practice guidelines, clinical utility of test results, and availability of testing services and health care providers to provide the necessary counseling for patients.[12] An additional study of oncologists' attitudes towards multiplex tumor genomic testing found that 50% felt "somewhat confident" in their knowledge about genetics and 22% expressed "low confidence" in their ability to explain genomic concepts.[13] Across studies, genomic confidence is a predictor of attitudes regarding the utilization of testing. The more confident and qualified the physician feels with genomics, the more likely the physician is to recommend testing.[13, 14] Factors associated with cancer susceptibility testing included physicians feeling very well or somewhat qualified to recommend testing, as opposed to those who felt not very or not at all qualified to recommend testing.[10]

These surveys of provider confidence are largely limited to a general population of physicians and adult oncologists across diverse clinical settings. It is not clear if confidence and comfort with genomic sequencing results are higher among pediatric oncologists practicing in a comprehensive cancer center where exposure to precision medicine initiatives may be more common. St. Jude Children's Research Hospital is a National Comprehensive Cancer Network (NCCN) Facility located in Memphis, TN accepting approximately 500 new pediatric oncology patients per year. In 2015, our institution developed a prospective study (Genomes for Kids) to assess the feasibility of integrating CGES into the clinical care of children with cancer. As the study and study-related procedures and educational materials were developed, it was recognized that physician self-assurance with understanding, communicating and utilizing CGES results were important considerations. Therefore, prior to initiating Genomes for Kids, providers were surveyed about their confidence, knowledge and perceived risks and benefits of CGES using tumor and germline samples from pediatric oncology patients undergoing cancer treatment at St. Jude. In addition, providers were asked about their preferences for results disclosure and interest in assistance from a genetic counselor (GC). At the time of survey participation no formal institutional sequencing protocols existed; however, oncologists were free to order somatic sequencing on an ad hoc basis in patients they suspected of having a tumor with a potentially targetable lesion. St. Jude enrolls approximately 78 patients annually (2005–2015 average) on early phase (Phase I/II) research studies with only a minority of these requiring clinical somatic sequencing (for identification of a target lesion) for study enrollment.

METHODS

Participants

All pediatric hematology/oncology physicians with clinical responsibilities in oncology were invited to participate in a de-identified electronic survey in August 2015. This Institutional Review Board-approved survey was distributed via email to 58 attending physicians and 30 hematology/oncology fellows. Informed consent was obtained by wavier and implied by survey completion.

Survey Instrument

Survey questions were developed following a review of the literature and multi-disciplinary needs assessment to identify knowledge gaps and areas of current debate around the integration of clinical genomics in pediatrics and pediatric oncology. Face validity of these questions was established through expert review by researchers in clinical genomics, nursing research, pediatric oncology, and bioethics. This mixed-methods survey most commonly provided response options followed by an optional box for qualitative clarification (Supplemental file – survey instrument). The survey was administered via SurveyMonkey® with an estimated time to completion of less than 15 minutes. The survey included Likert-based quantitative questions specific to clinician confidence in interpreting, discussing and utilizing the somatic and germline sequencing results as well as areas for qualitative responses. Physicians were queried about their preferred method of learning about information contained in somatic and germline reports and their preferences around results disclosure. The survey also elicited physician perceptions about their expectations for utilizing CGES results in clinical care as well as the risks and benefits of CGES testing.

Statistical Analysis

Descriptive statistics (number and percent) were reported for questionnaire responses. Chi-square or Fisher's exact tests (for sparse data) were used to compare questionnaire responses between responder subgroups. Subgroups were defined by type of provider (fellow vs. physician) and by questionnaire responses related to confidence in knowledge of interpreting results of somatic and germline genomic findings (non-confident vs. confident). We defined confident as a response of 4 or higher on a five-point scale (1=not at all confident, 2=not at all confident to unsure, 3=unsure, 4=unsure to very confident, 5=very confident). Statistical analyses were conducted with SAS 9.4 (SAS Institute, Cary, NC). A two-sided significance level of $P<0.05$ was used for all statistical tests. Raw p-values are reported, but were adjusted for multiple testing using the false discovery rate to ensure statistical significance.

RESULTS

Demographics

Of the 88 physicians who received the survey, 30 attending physicians and 22 fellows responded, yielding an overall response rate of 59%. Throughout the survey there were no statistical differences observed in the responses between physicians and fellows. Given the small sample size, no statistical comparisons were conducted between oncologic specialties.

Provider Confidence

Providers were asked about confidence in three domains: interpreting, utilizing, and discussing somatic and germline genomic results (Table I). Approximately 50% of respondents stated a lack of confidence across all domains (48% somatic, 52% germline). Of the remaining respondents, 35% were confident in all three aspects of somatic results; 27% for germline CGES.

Confidence in interpreting the results of genomic results was mixed, with 23 (44%) of providers reporting confidence in interpreting somatic results and 21 (40%) reporting

confidence in interpreting germline results. Forty-six (88%) providers were concordant in their responses regarding somatic and germline confidence with only 19 stating they were confident in interpreting both types of genomic results and 27 stating they were not confident in interpreting either type of result. Six (12%) providers were discordant in their responses, with 4 providers confident only in interpreting somatic and 2 providers confident only in interpreting germline results.

Responses to subsequent questions were stratified based on whether or not a provider was confident interpreting somatic and germline results. Providers who reported confidence in interpreting somatic results were significantly more likely to have confidence in discussing somatic results with their patients and utilizing these results in patient care when compared to their colleagues who were not confident ($p<0.0001$, respectively; Table I). Similarly, providers who reported confidence in interpreting germline results were significantly more likely to have confidence in discussing and utilizing germline results when compared to their non-confident colleagues ($p<0.0001$, respectively; Table I).

Genetic Counselor Involvement

Provider input was elicited regarding GC involvement when disclosing germline results (Table II). Responding providers (n=40) had a strong preference for GC involvement, with 37 (93%) indicating a desire to speak with a genetic counselor *prior* to germline results disclosure and 27 (68%) indicating a preference to have a counselor present during the disclosure. Providers (n=40) were divided in their preferences around result disclosure, with 14 (35%) stating they would like to be the first to convey the germline results, 16 (40%) stating they did not wish to convey the germline results before the patient met with a GC, and 10 (25%) stating they were unsure. Of the 14 providers indicating they wanted to convey germline results before the patient met with a GC, 13 (93%) stated that they would like to consult a GC prior to results disclosure, and 7/13 (54%) reported a preference to have a GC present at the time of disclosure. No significant differences were observed based on provider confidence interpreting results.

Perceived Utility of Genomic Results

Regarding perceived utility of somatic CGES, 70% (28 of 40) of providers stated they would use somatic results when planning treatment for refractory or relapsed patients (Table III). Providers confident in interpreting somatic test results were significantly more likely than their non-confident colleagues ($p=0.009$) to state that they might use somatic results to plan treatment of refractory or relapsed patients. Those providers who stated that they would use somatic results (n = 28) were asked follow-up questions to assess how they might utilize this information; 93% reported they would use results to find a new study for the patient, 93% would add a specific drug to the patient's current regimen, and 79% would adjust current treatment.

With regards to the utility of germline test results, 60% (24 of 40) of providers indicated that they would use this information to tailor treatments (Table III). However, providers who indicated confidence in interpreting germline results were not significantly more likely than their non-confident colleagues to indicate they would use germline results to tailor treatment.

Providers who indicated that they would use germline results (n=24) were asked follow-up questions around this utilization and 67% reported they would use results to find a new study for the patient, 63% would add a specific drug to the patient's current regimen, and 88% would adjust current treatment.

Preferences for Genomic Reports

We elicited provider preferences regarding the data elements they prefer to accompany CGES reports (Supplemental Table). The strongest preference for somatic reports was information on variant actionability (75%) and a description of the genes altered with associated medical conditions (67%) on germline reports. No significant differences for data elements were observed based on level of training or provider confidence.

Perceived Risks and Benefits

Providers were asked a series of questions on their perceived risks and benefits of patient participation in the upcoming genomic sequencing study Genomes for Kids (Table IV). Of the potential risks, psychosocial impact was of concern for 73% of providers, followed by concern for loss of insurability for 46%, and concern for impact on privacy or confidentiality for 35%. Of the potential benefits, surveillance for and early treatment of secondary cancers (both for the enrolled pediatric oncology patient and for other family members) was indicated to be of importance to 75% of providers. Sixty nine percent of providers indicated that CGES information would be beneficial in understanding cancer risk in the family and 60% stated a benefit in identifying the cause of the patient's cancer. No significant differences were observed based on provider confidence interpreting CGES.

DISCUSSION

In this survey we focused on confidence, utilization, and communication surrounding CGES among pediatric hematology/oncology providers working at an NCCN facility. In other studies, confidence is usually associated with medical oncology, being a researcher, and access to baseline genetic testing;[13] yet despite these factors being applicable to the clinical providers surveyed in this study, confidence rates were no higher than reported elsewhere. Our results illustrate that even among this specialized group of pediatric hematology/oncology physicians practicing in an area with an established role for precision medicine initiatives, at least 50% indicate non-confidence in their ability to interpret, discuss, and utilize CGES findings. Given the recent emphasis on molecular tumor profiling in the oncology community, the low confidence around somatic genomic data was surprising and may represent a potential barrier to the successful translation of somatic genomic data into therapeutic decision making. Given that less than one-third of respondents expressed confidence in all three domains around germline CGES, identifying an oncology peer knowledgeable in genomics may be challenging. Our results indicate that further education is necessary across all physician experience levels (fellow and attending physician) for the purpose of increasing provider confidence around clinical genomics. Pediatric molecular tumor boards may be one venue for efficiently ascribing pathogenicity and actionability of CGES findings across a diverse base of oncologists.[16]

Knowledge of the pathogenicity of genomic variants is being increasingly described [17–20] and standards for variant interpretation are evolving. The speed of these changes may make it difficult for clinicians to stay up-to-date with advances in the field, limiting provider confidence in discussing and utilizing genomic findings in a patient's plan of care. Further research should define the needs of providers who are seeking to incorporate CGES into practice and delineate the best methods for communicating the implications of genomic findings to providers. For example, it was recently recommended that laboratories clearly communicate standards for variant validation and depth of coverage in a manner that informs providers of potential limitations on clinical utility.[21] Many CGES reports include information about the actionability of pathogenic findings. This data element is important to a majority of participants; yet it is not clear if CGES reports are the ideal vehicle for conveying actionability information that is changing rapidly. Furthermore, laboratories do not always have the necessary clinical information on a patient's medical and family history or any associated physical stigmata to fully interpret the meaning an identified germline variant. Based upon results of provider preferences and needs, professional organizations, such as the American Society of Clinical Oncology or American College of Medical Genetics may wish to continue developing clinical practice pathways (i.e. algorithms) to guide physicians trying to utilize CGES results for tailoring patient care and to update algorithms in a timely manner as variant interpretation is further refined.

Given the lack of confidence around CGES, it is not surprising that approximately two-thirds (27 of 40) of respondents, regardless of confidence level, desired that a GC be present when germline findings were conveyed to a patient and family. Nearly all respondents 37 of 40, (93%) wished to speak with a GC *prior* to the results disclosure. These results suggest that a shared-disclosure model may be preferred by many oncologists and highlights the importance of having trained GCs available for both providers and patients.

In recent recommendations from the Clinical Genetics Think Tank (CGTT), experts identified the importance of genomics education and training to provide clinicians with the knowledge base for evaluating the appropriateness of CGES and providing adequate pre-test counseling.[21] There may be significant risks of harm when clinicians who are inadequately trained to order, discuss, and evaluate CGES results do so independently. As an example, patients may be harmed by excess or inadequate screening or treatment as a result of inappropriate interpretation and application of CGES results thus violating the ethical principle of non-maleficence. The CGTT suggested that centers may wish to develop an institutional gatekeeper to review requests for CGES testing and coordinate provider education.[21] At our institution, this expertise is coordinated by a multidisciplinary team of specialists from oncology, genetics, ethics, nursing research and psychology. This team supports the interpretation and disclosure of germline CGES results and is available to facilitate re-evaluation and communication of revised germline CGES results as variants are re-interpreted over time. While these services are consistent with many CGTT recommendations, smaller institutions with less expertise and/or resources may find these recommendations difficult to implement. These centers may find value in supporting advanced training for their providers on the translation of CGES into patient care and to partner with larger academic centers; perhaps via regularly scheduled video or teleconferencing.

Survey respondents saw many potential benefits to CGES; particularly that CGES might facilitate surveillance and early treatment for second cancers/cancer in the patient or their family. This potential benefit, however, must be balanced against current limitations in the understanding of genotype-phenotype relationships, variability in disease penetrance and expression, potential risks of unnecessary screening and treatment, and adverse psychological outcomes related to cancer worry. In fact, psychological impact of genomic testing was the most commonly endorsed risk (73%) of CGES among respondents; whereas loss of insurability and privacy concerns were risks identified by less than half. Parents do not appear to share the same concerns about psychological risk[22] and it is unknown how provider perceptions of risk and benefit influence their conversations with patients around CGES. As a result, this area provides ample opportunities for future research.

This is a single-institution investigation of physicians at a pediatric NCCN facility and as such, our findings may not generalize to pediatric oncologists practicing elsewhere; although we anticipate genomic confidence is likely low at other smaller institutions based upon findings previously reported among adult oncologists.[13] It also remains uncertain whether expressed self-confidence in understanding and utilizing CGES is indicative of true skill. Another potential limitation involves response bias and limited demographic information about survey respondents. Although our response rate is consistent with other physician surveys, it is possible that non-respondents may have been more or less comfortable with CGES or represent a certain demographic within this field. Participants were allowed to skip questions or to answer “I don’t know” and it’s possible that participants with very low genomic confidence may not have had strong attitudes or beliefs around some of the survey questions, resulting in a decision to skip the question or check the uncertain response. Finally, due to the limited availability of validated questionnaires for clinical genomics, this internally developed survey is the first use of this instrument amongst physicians in any field.

In summary, we found that confidence in interpreting, discussing, and/or utilizing CGES results was low among physicians practicing at a site focused on the treatment of pediatric cancers. Providers had a strong preference to work with a GC around the disclosure of germline results as well as interest in support when determining the actionability of identified somatic genomic variants. These findings highlight the need to identify the best methods for providing clinicians with basic competencies in understanding CGES and in appropriate utilization of results in clinical care. To further optimize the interpretation and integration of CGES results into clinical oncology, multi-disciplinary collaboration and communication between oncologists, geneticists, GCs, pathologists, clinical laboratories, computational biologists and basic researchers is essential. Interdisciplinary growth in this area is encouraged, but should be supported by organized research into best practices.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table I

Provider Confidence in Interpreting, Discussing, and Utilizing *Somatic* and *Germline* Genomic Findings

		Role			*Somatic* Confidence[a]		
How confident are you of:	**All (N=52)**	**Fellow (n=22)**	**Physician (n=30)**	**P**	**Non-Confident (n=29)**	**Confident (n=23)**	**P**
Interpreting the results of *somatic* genomic findings?							
Non-Confident	29 (56)	13 (59)	16 (53)	NS[#]			
Confident	23 (44)	9 (41)	14 (47)				
Discussing *somatic* genomic findings with your patient and his/her family?							
Non-Confident	28 (54)	13 (59)	15 (50)	NS[#]	26 (90)	2 (9)	<0.0001[*]
Confident	24 (46)	9 (41)	15 (50)		3 (10)	21 (91)	
Utilizing *somatic* genomic findings in your patient's care?							
Non-Confident	31 (60)	15 (68)	16 (53)	NS[#]	27 (93)	4 (17)	<0.0001[*]
Confident	21 (40)	7 (32)	14 (47)		2 (7)	19 (83)	

		Role			*Germline* Confidence[b]		
How confident are you of:	**All (N=52)**	**Fellow (n=22)**	**Physician (n=30)**	**P**	**Non-Confident (n=31)**	**Confident (n=21)**	**P**
Interpreting the results of *germline* genomic findings?							
Non-Confident	31 (60)	13 (59)	18 (60)	NS[#]			
Confident	21 (40)	9 (41)	12 (40)				
Discussing *germline* genomic findings with your patient and his/her family?							
Non-Confident	33 (63)	15 (68)	18 (60)	NS[#]	28 (90)	5 (24)	<0.0001[*]
Confident	19 (37)	7 (32)	12 (40)		3 (10)	16 (76)	
Utilizing *germline* genomic findings in your patient's care?							
Non-Confident	35 (67)	17 (77)	18 (60)	NS[#]	29 (94)	6 (29)	<0.0001[*]
Confident	17 (33)	5 (23)	12 (40)		2 (6)	15 (71)	

Data presented as frequency (percent).

[#]NS = Not statistically significant, p > 0.05.

[*]Remains statistically significant (P<0.05) after false discovery rate adjustment.

[a] Defined as confidence in knowledge of interpreting results of *somatic* genomic findings.

[b] Defined as confidence in knowledge of interpreting results of *germline* genomic findings.

Table II

Involvement of a Genetic Counselor in CGES Results Disclosure

		Role			*Germline* Confidence[b]		
	All (N=40)[a]	**Fellow (n=16)**	**Physician (n=24)**	**P**	**Non-Confident (n=23)**	**Confident (n=17)**	**P**
Do you want to convey germline findings to your patient prior to the results disclosure by a genetic counselor?							
I don't know.	10 (25)	6 (38)	4 (17)	NS[#]	6 (26)	4 (24)	NS[#]
No	16 (40)	3 (19)	13 (54)		12 (52)	4 (24)	
Yes	14 (35)	7 (44)	7 (29)		5 (22)	9 (53)	
Would you like for a counselor to be present with you as you convey these findings to your patient?							
I don't know.	8 (20)	3 (19)	5 (21)	NS[#]	4 (17)	4 (24)	NS[#]
No	5 (13)	1 (6)	4 (17)		2 (9)	3 (18)	
Yes	27 (68)	12 (75)	15 (63)		17 (74)	10 (59)	
Would you like to speak with a counselor or member of the study team prior to disclosing results to the patient?							
I don't know.	2 (5)	1 (6)	1 (4)	NS[#]	2 (9)	0 (0)	NS[#]
No	1 (3)	0 (0)	1 (4)		0 (0)	1 (6)	
Yes	37 (93)	15 (94)	22 (92)		21 (91)	16 (94)	

Data presented as frequency (percent).

[a]Data was missing for 12 respondents.

[b]Defined as confidence in knowledge of interpreting *germline* genomic findings.

NS[#] = Not statistically significant ($p > 0.05$)

Table III

Utilizing Sequencing results

	***Somatic* Sequencing Results**						
		Role			***Somatic* Confidence[b]**		
	All (N=40)[a]	**Fellow (n=16)**	**Physician (n=24)**	**P**	**Non-confident (n=22)**	**Confident (n=18)**	**P**
Do you think that you might use *somatic* genomic sequencing results in planning treatment for your refractory or relapsed patients?							
I don't know	8 (20)	2 (13)	6 (25)	NS[#]	8 (36)	0 (0)	0.009[*]
No	4 (10)	0 (0)	4 (17)		2 (9)	2 (11)	
Yes	28 (70)	14 (88)	14 (58)		12 (55)	16 (89)	
If you would utilize tumor genomic sequencing results in planning treatment for your refractory or relapsed patients, how would you use this information? Check all that apply.[c]							
To find a new study for the patient	26 (93)	14 (100)	12 (86)	NS[#]	10 (83)	16 (100)	NS[#]
To add a specific drug to the patient's current regimen	26 (93)	13 (93)	13 (93)	NS[#]	11 (92)	15 (94)	NS[#]
To adjust current treatment (reduce or eliminate certain drug(s) or radiation treatment)	22 (79)	12 (86)	10 (71)	NS[#]	10 (83)	12 (75)	NS[#]
	***Germline* Sequencing Results**						
		Role			***Germline* Confidence[b]**		
	All (N=40)[a]	**Fellow (n=16)**	**Physician (n=24)**	**P**	**Non-confident (n=23)**	**Confident (n=17)**	**P**
Do you think that you might use *germline* genomic sequencing results in planning treatment for your refractory or relapsed patients?							
I don't know	14 (35)	5 (31)	9 (38)	NS[#]	10 (43)	4 (24)	NS[#]
No	2 (5)	0 (0)	2 (8)		2 (9)	0 (0)	
Yes	24 (60)	11 (69)	13 (54)		11 (48)	13 (76)	
If you would utilize tumor genomic sequencing results in planning treatment for your refractory or relapsed patients, how would you use this information? Check all that apply.[c]							
To find a new study for the patient	16 (67)	8 (73)	8 (62)	NS[#]	9 (82)	7 (54)	NS[#]
To add a specific drug to the patient's current regimen	15 (63)	8 (73)	7 (54)	NS[#]	9 (82)	6 (48)	NS[#]
To adjust current treatment (reduce or eliminate certain drug(s) or radiation treatment)	21 (88)	9 (82)	12 (92)	NS[#]	10 (91)	11 (85)	NS[#]

Data presented as frequency (percent).

[a] Data was missing for 12 respondents.

[b] Defined as confidence in knowledge of interpreting genomic findings.

[c] Sample size is based on the number of respondents that might use genomic results (i.e. response of "Yes" for the question above).

* Remains statistically significant (P<0.05) after false discovery rate adjustment.

NS# = Not statistically significant (p > 0.05).

Table IV

Risks and Benefits of Clinical CGES in Pediatric Oncology

		Role			*Somatic* Confidence[a]			*Germline* Confidence[b]		
	All (N=52)	**Fellow (n=22)**	**Physician (n=30)**	**P**	**Non-confident (n=29)**	**Confident (n=23)**	**P**	**Non-confident (n=31)**	**Confident (n=21)**	**P**
What do you perceive as potential risk for your patients and their families by participating in this study? Check all that apply.										
Psychological impact	38 (73)	14 (64)	24 (80)	NS[#]	21 (72)	17 (74)	NS[#]	22 (71)	16 (76)	NS[#]
Loss of insurability	24 (46)	8 (36)	16 (53)	NS[#]	13 (45)	11 (48)	NS[#]	13 (42)	11 (52)	NS[#]
Privacy or Confidentiality impact	18 (35)	5 (23)	13 (43)	NS[#]	12 (41)	6 (26)	NS[#]	13 (42)	5 (24)	NS[#]
What do you perceive as potential benefits for your patients and families by participating in this study? Check all that apply.										
Identification of the cause for the patient's cancer	31 (60)	12 (55)	19 (63)	NS[#]	16 (55)	15 (65)	NS[#]	16 (52)	15 (71)	NS[#]
Help detailing the cancer risk in the family.	36 (69)	13 (59)	23 (77)	NS[#]	20 (69)	16 (70)	NS[#]	20 (65)	16 (76)	NS[#]
Facilitating surveillance and early treatment for second cancers in the patient.	39 (75)	16 (73)	23 (77)	NS[#]	21 (72)	17 (81)	NS[#]	22 (71)	17 (81)	NS[#]
Facilitating surveillance and early treatment for cancer in family members.	39 (75)	16 (73)	23 (77)	NS[#]	22 (76)	17 (74)	NS[#]	22 (71)	17 (81)	NS[#]

Data presented as frequency (percent).

[a]Defined as confidence in knowledge of interpreting results of *somatic* genomic findings.

[b]Defined as confidence in knowledge of interpreting results of *germline* genomic findings.

NS[#] = Not statistically significant