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ORIGINAL RESEARCH

Reporting Incidental Findings in Clinical Whole Exome Sequencing: Incorporation of the 2013 ACMG Recommendations into Current Practices of Genetic Counseling

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Abstract The purpose of this study was to investigate how the American College of Medical Genetics and Genomics (ACMG) March 2013 recommendations for reporting incidental findings (IFs) have influenced current practices of genetic counselors involved in utilizing whole exome sequencing (WES) for clinical diagnosis. An online survey was sent to all members of the National Society of Genetic Counselors; members were eligible to participate if they currently offered WES for clinical diagnosis. Forty-six respondents completed the survey of whom 34 were in practice prior to the March 2013 ACMG recommendations. Half of respondents (*N*=19, 54.9 %) in practice prior to March 2013 reported that the ACMG recommendations have had a significant impact on the content of their counseling sessions. Approximately half of respondents (*N*=21, 45.5 %) report all IFs, regardless of patient age, while one third (*N*=14, 30.4 %) consider factors such as age and parent preference in reporting IFs. Approximately 40 % (*N*=18) of respondents reported that the testing laboratory's policy for returning IFs has an influence on their choice of laboratory; of those, 72.2 % (*N*=13) reported that the option to opt out of receiving reports of IFs has a significant influence on their choice of laboratory. A majority of respondents (*N*=43, 93.5 %) found that most patients want to receive reports of IFs. However, respondents report there are patients who wish to decline receiving this information. This study querying genetic counselors identified benefits and challenges that the 2013 ACMG recommendations elicited. Some challenges, such as not having the option to opt out of IFs, have been addressed by the ACMG's most recent updates to their recommendations. Further investigation into larger and more inclusive provider populations as well as patient populations will be valuable for the ongoing discussion surrounding IFs in WES.

Keywords Whole exome sequencing · Incidental finding · American College of Medical Genetics and Genomics · Genetic counseling · Autonomy

Introduction

Recent advancements in technology and the subsequent decrease in time and cost of DNA sequencing have led clinicians to more readily turn to whole exome sequencing (WES) as a diagnostic tool when a genetic etiology is suspected but remains elusive. WES has the potential to uncover vast amounts of genetic information, including information that may have clinical implications but is unrelated to the initial indication for testing; this information has been deemed "incidental findings" (IFs). The potential for discovering these IFs has stirred debate among clinicians over the ethical considerations of reporting IFs, specifically the balance between medical beneficence and patient autonomy (Ormond et al. 2010; Green et al. 2013b). Previous studies have attempted to identify the types of IFs that should be disclosed (Green et al. 2012; Grove et al. 2014) and to explore the process of

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obtaining informed consent (Ayuso et al. 2013). However, no specific guidelines had been suggested.

In March 2013, the American College of Medical Genetics and Genomics (ACMG) released their recommendations for reporting IFs in clinical exome and genome sequencing. According to these recommendations, pathogenic mutations found in any of 56 selected genes, associated with 24 conditions, should be reported by all testing laboratories to the ordering clinician, regardless of patient preference or age (Green et al. 2013a). The clinician should "contextualize these findings to the clinical circumstances (e.g…patient preferences, etc.) and the provider and patient will participate in a shared decision-making process regarding the return of results" (ACMG 2013). The ACMG targeted these conditions because they are actionable; the morbidity and/or mortality of the associated disease may be alleviated through early screening or treatment (Green et al. 2013a). Additionally, adherence to these recommendations would provide the added benefit of ensuring consistency in reporting IFs among all laboratories (Green et al. 2013b).

The National Society of Genetic Counselors (NSGC) subsequently released a media statement in response these recommendations (NSGC 2013). In this statement they applauded the ACMG for identifying and attempting to fulfill a need for established guidelines for reporting IFs in whole exome and genome sequencing. However, the NSGC also pointed out that the recommendations were not consistent with maintaining patient autonomy. The NSGC argued that patients should have the option of making an informed decision regarding what information they want or do not want to receive, and that this decision-making process should be informed by comprehensive pre-test counseling and consent procedures.

Supporters of the recommendations agree with the ACMG in that reporting these findings may prevent harm, which, they believe, outweighs concerns regarding patient autonomy. Regarding children, supporters argue that this information could be useful in early screening and in warning relatives about potential risks (Vayena and Tasioulas 2013).

Opponents have argued that these recommendations strip patients of their autonomy and their right not to know certain genetic information. Opponents extend this reasoning to children, believing that all children should have the right to a naïve childhood, and be able to choose (or decline) this testing at an appropriate age (Klitzman et al. 2013; Ross et al. 2013). Although proponents argue that patient autonomy lies within the option to decline testing altogether, doing so would force patients to reject this valuable technology based solely on the implications of testing for IFs (Burke et al. 2013; Klitzman et al. 2013).

The March 2013 release of the initial ACMG recommendations stirred a vigorous debate throughout the genetics community, generating conflicting opinions about what medical providers consider important knowledge and what the patient actually wants to know. However, there was a lack of published data regarding how medical professionals and their patients have responded to the incorporation of these recommendations. The purpose of this study was to 1) examine how the initial ACMG recommendations influenced or changed the current practices of genetic counselors offering whole exome sequencing (WES), including the consent process, the testing of children and the choice of testing laboratory, 2) to identify benefits and challenges that the ACMG Recommendations have elicited for genetic counselors and 3) to obtain genetic counselors' perspectives on how patients have reacted to the idea of receiving reports of the ACMG-recommended IFs. Since the completion of this study, the ACMG released updated recommendations which state: "patients should have an opportunity to opt out of the analysis of medically actionable genes when undergoing whole exome or genome sequencing". The ACMG's decision to update these recommendations reportedly resulted from the ongoing discussion surrounding IFs in WES in addition to a survey of ACMG members (ACMG 2014). Our findings support these recommendations. These, along with other findings in this study may help to inform the ongoing process of developing guidelines for reporting IFs.

Materials and Methods

Study Design and Participants

The study consisted of an anonymous online survey which was emailed to all ~2900 members of the NSGC. Individuals were eligible to participate if their current practice offers WES for clinical diagnosis. Eligible respondents were directed to one of two survey branches. One branch was targeted to genetic counselors who were in practice before and after the March 2013 release of the ACMG recommendations. These respondents were asked about their current practices regarding IFs and to compare their practices before and after the release of the ACMG recommendations. The second branch was targeted to genetic counselors who began practice after the March 2013 release of the ACMG recommendations. They were asked about current practices only.

This research protocol was approved by the Brandeis University Committee for Protection of Human Subjects Institutional Review Board (IRB), Protocol #14037. Respondents provided consent for participation in our study by entering the survey. Funding for this project was provided by the Brandeis University Graduate School of Arts and Sciences.

Data Collection and Analysis

The survey was designed and administered through Qualtrics®. The survey, which was developed by the authors,

was available from October 17, 2013 to November 30, 2013 and consisted of multiple choice (mostly categorical and quantitative scales) as well as write-in questions allowing short qualitative responses. Major topics assessed were changes and/or challenges to their practice, considerations in reporting IFs in children, factors affecting choice of testing laboratories and patient reactions about receiving IFs. Participants were able to skip any question. The survey took approximately 20 min to complete. One reminder was sent 2 weeks after the initial survey was administered. As an incentive to participate in the study, participants were given the opportunity to enter a drawing for one of two $50 Amazon.com gift cards upon completion of the survey. For the qualitative answers, we coded the responses to identify common themes. Due to the small participant sample size, we provided descriptive statistics only; additional statistical analysis was not performed. Data was analyzed using SPSS software version 21.0.0.

Results

Participants

Our survey was sent to all NSGC members. A total of 78 respondents began the survey. Of these, 46 were eligible and completed the survey; the demographic representation of these respondents in depicted in Table 1. The number of NSGC members who meet eligibility requirements is unknown so the true response rate cannot be calculated. The 32 respondents excluded from this analysis included genetic counselors who offer WES in a research or a commercial testing laboratory, and respondents who did not answer any questions after beginning the survey. Of the 46 respondents who were eligible and completed the survey, 34 had offered WES prior to the March 2013 release of the ACMG recommendations.

Table 1 Demographic data

	Category	*N*	%
Gender			
	Female	44	95.7 %
	Male	2	4.3 %
Ethnicity			
	White	37	80.4 %
	Black	2	4.3 %
	Hispanic	1	2.2 %
	Asian	3	6.5 %
	Other	2	4.3 %
Specialty			
	Pediatrics	35	76.1 %
	Prenatal	3	6.5 %
	Cancer	1	2.2 %
	Other[a]	7	15.2 %
Years in practice			
	<1	2	4.3 %
	1–2	15	32.6 %
	3–4	7	15.2 %
	5–6	5	10.9 %
	7–8	7	15.2 %
	9–10	3	6.5 %
	>10	6	13.0 %

[a] Combined Pediatrics/Adult, Pediatrics/Prenatal, Pediatrics/Cancer; Specialty Clinics

Pre-Test Counseling: Comparing Before & After

In comparing current practices to those prior to the release of the recommendations (*N*=34), 19 respondents (54.9 %) agreed that the recommendations had a significant impact on the content of their session, 7 respondents (20.6 %) disagreed, and 8 respondents (23.5 %) neither agreed nor disagreed. Twenty-one respondents (61.8 %) reported that the amount of time they spent counseling patients on IFs has increased, 12 respondents (35.3 %) reported no change, and 1 respondent (2.9 %) reported a decrease (Fig. 1a). When presented with the statement "My counseling sessions are more challenging", 8 respondents (23.5 %) reported they agreed, 13 respondents (38.2 %) neither agreed nor disagreed, and 13 respondents (38.2 %) disagreed (Fig. 1b). One respondent wrote, "Having a concrete list specifying the types of conditions that could be reported has helped to provide more accurate counseling for IFs", and another wrote, "There are now concrete examples of what IFs may be for patients and what this might mean for their healthcare".

Patient Preferences & Testing in Children: Current Practices

Among all who completed the survey (*N*=46), in response to the statement "In general I find that my patients want to receive reports of incidental findings" 43 respondents (93.5 %) indicated the statement was true, while 3 respondents (6.5 %) indicated the statement was false.

In the free response section, we asked respondents about their perception of reasons why patients are hesitant about, or choose to opt out of, receiving reports of IFs. Of the 5 respondents who offer WES to adults, 2 reported that patients were solely concerned with the presenting medical issue, 1 reported that their patient(s) did not want to know about cancer syndromes and 2 reported that none of their patients have opted out of receiving IFs. Of 31 respondents who offer WES to children, the responses included one or more of the following reasons: cultural reasons (stigma and future marriageability), anxiety, too much information, parents are already overwhelmed with the 'diagnostic odyssey', parents

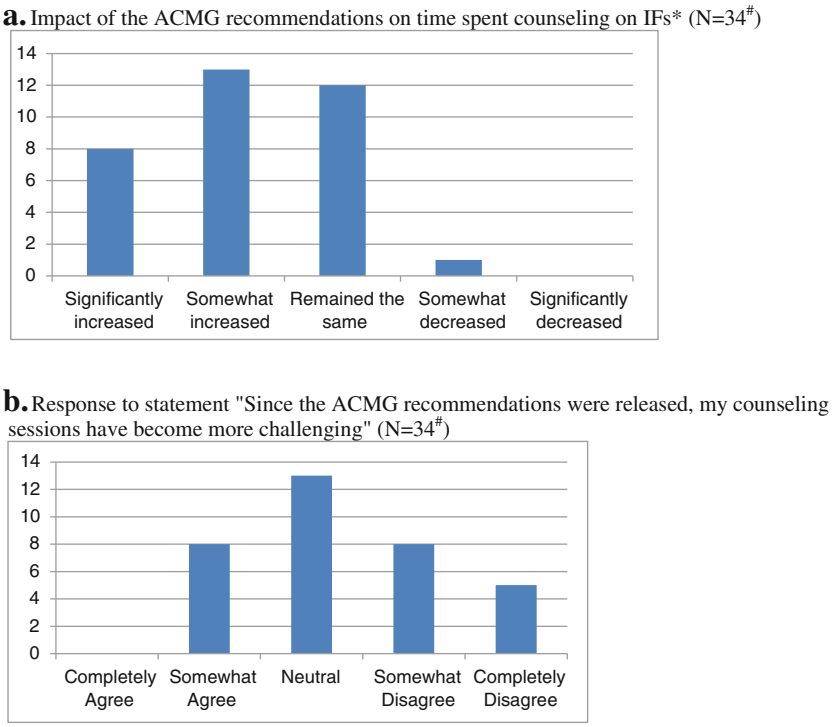

Fig. 1 Impact of the ACMG recommendations on genetic counseling sessions

*Incidental Findings
#Respondents in practice when the ACMG recommendations were released

learning unwanted information about themselves, and fear of insurance discrimination. One respondent reported that some of their families declined testing because they "felt uncomfortable" with learning about IFs. Another respondent reported that a teenage patient declined learning about IFs. Six respondents reported that none of their patients (or for young children, their parents) were interested in opting out of receiving IFs.

When all respondents (N=46) were asked what considerations they placed on reporting incidental findings in children (Table 2), 14 respondents (30.4 %) reported that they consider several factors when reporting IFs in children. Of those factors, all respondents (N=14) considered the age of the patient to have a significant or somewhat significant influence on whether they report IFs. Within the same group, all respondents reported that parental request has a significant or somewhat significant influence on their decision to report IFs. Nine of the 14 respondents (64.2 %) reported that they most often send their samples to a laboratory that offers the option to opt out of receiving reports of IFs, 3 of the 14 respondents (21.4 %) most often use a laboratory that does not offer the option to opt out, and 2 of the 14 respondents (14.3 %) did not know whether the laboratory they most often use offers the option to opt out. Twenty-one respondents (45.7 %) report all IFs regardless of age. Fourteen of the 21 respondents (66.7 %) reported that they most often send their samples to a laboratory that offers the option to opt out of receiving reports of IFs, 4 of the 21 respondents (19.0 %) most often use a laboratory that does not offer the option to opt out, and 3 of the 21 respondents (14.2 %) did not know whether the laboratory they most often use offers the option to opt out. Three respondents (6.7 %) reported that they do not offer WES to children. The remaining respondents, (N=8) chose "other", 3 of whom specified that it was the parents' decision while 2 reported that they had not encountered a situation where the parents did not want to know this information and did not know how they would handle such a situation. The remaining 3 respondents did not provide any additional information.

Laboratory Reporting

We asked all respondents (N=46) if laboratory reporting policies influenced the choice of testing laboratory (Table 3). Of the 45 who responded, 18 respondents (40.0 %) reported that a laboratory's policy for handling IFs influenced their choice; 13 (72.2 %) of these respondents specified that laboratories offering the option to opt out of receiving reports of IFs had a significant influence on their choice to send patients' samples there and 6 (33.3 %) of these respondents specified that laboratories not offering the option to opt out of receiving reports of IFs had a significant influence on their choice to send patients' samples there. Notably, one respondent chose both options; that the laboratory offering the option to opt out *and* the laboratory not offering the option to opt out of

Table 2 Considerations respondents place on reporting incidental findings in children (N=46[#])

What considerations do you place on reporting IFs[a] in children?			
None- I report all IFs[a] in children	21 (45.7 %)	Most frequently send samples to labs that offer option to opt out	14
		Most frequently send samples to labs that do not offer option to opt out	4
		I do not know about opt out policies for the lab that I most frequently send samples to	3
It depends, I consider several factors[b]	14 (30.4 %)	Most frequently send samples to labs that offer option to opt out	9
		Most frequently send samples to labs that do not offer option to opt out	3
		I do not know about opt out policies for the lab that I most frequently send samples to	2
I do not offer WES to children	3 (6.7 %)		
Other	8 (17.8 %)		

[#] All respondents completing the survey; indicates current practices since ACMG recommendations were released

[a] Incidental findings

[b] 14/14 consider the age of the child and parental request significant/somewhat significant in reporting incidental findings in children

receiving IFs had a significant influence on their decision to send their patient's samples there. However, this respondent did not provide any clarifying information.

Of the respondents who reported that the laboratory they most often use does not offer the option to opt out of receiving reports of incidental findings (N=8), none offer the patient that option (Table 3). One respondent wrote, "in the age of electronic medical records, there are too many risks for accidental disclosure". Twenty-seven of the 45 respondents (60.0 %) reported that the laboratory reporting policies did not influence their choice of testing lab.

When we asked respondents who were in practice prior to the release of the ACMG recommendations (N=34) to identify any challenges resulting from the incorporation of the ACMG recommendations, 3 out of the 22 respondents (13.6 %) identified confusion over differing laboratory policies regarding IFs as a challenge. One respondent wrote, "We use one of two labs for WES depending on insurance, and these two labs have different policies regarding release of IFs". Another wrote, "we tailor our counseling based on which lab we are using and how they treat these recommendations… I had to re-learn the consent forms for the different labs". A third respondent wrote, "Many labs are offering WES and each has different options about incidentals. This makes me think that we may have to match lab to patient".

Incorporation of the ACMG Recommendations & Future Guidelines

We asked respondents (N=34) what educational resources their institution had provided to them following the release of the ACMG recommendations; respondents could choose all options that applied. Five respondents (14.7 %) had a group meeting to discuss how they would handle IFs, 6 respondents (17.6 %) discussed this in a meeting with a supervisor, 2 respondents (5.9 %) received written guidelines, 2 respondents (5.9 %) had both a meeting with their supervisor and received written guidelines, 7 respondents (20.6 %) received no information even though they reportedly changed their practices based on the ACMG recommendations, 3 respondents (8.8 %) reported that they independently read the recommendations but nothing formal was released, and 8 (23.5 %) received no information because they did not change their practices.

We asked all respondents (N=46) if they felt that there is a need for practice guidelines that incorporate all aspects (counseling, consenting, results reporting) of clinical WES, 32 respondents (69.9 %) indicated that such a need does exist, 7 respondents (15.2 %) indicated there was no need, and 7 respondents (15.2 %) reported that they did not know. We then asked respondents who should be involved in the creation of such guidelines (they could choose all that applied), 43 respondents (97.7 %) chose genetic counselors involved in clinical care, 35 respondents (79.5 %) chose genetic counselors in commercial laboratories, 31 respondents (70.5 %) chose genetic counselors involved in WES research, 28 respondents (63.6 %) chose laboratory medical directors, 42 respondents (95.5 %) chose medical geneticists, 39 respondents (88.6 %) chose professional organizations such as the ACMG and the NSGC, and 18 respondents (40.9 %) chose patients.

Discussion

The goal of this study was to investigate how genetic counselors have incorporated the ACMG recommendations, including benefits and challenges that the ACMG recommendations have elicited, and to gain genetic counselors' perspectives on how patients have reacted to the incorporation of these recommendations. Consistent with other studies, we found that, while respondents appreciated being provided specific guidelines when discussing IFs (Burke et al. 2013; Spatz and Spertus 2012) and reported that most patients want to receive reports

Table 3 Laboratory reporting policies

a. Does a laboratory's practice for handling IFs[a] influence your decision to send your patients' samples there (N=45[#])?		
Yes	18 (40 %)	Significant/somewhat significant that lab offers option to opt out 13 (72.2 %)
		Not at all significant that lab offers option to opt out 3 (16.7 %)
		Not applicable 2 (11.1 %)
No	27 (60 %)	Significant/somewhat significant that lab does NOT offer option to opt out 6 (33.3 %)
		Not at all significant that lab does NOT offer option to opt out 5 (27.8 %)
		Not applicable 7 (38.9 %)
b. Does the testing laboratory that you most often send your patient samples to provide the option to opt out of receiving IFs (N=46[ŧ])?		
Yes	32 (69.6 %)	
No	8[¥] (17.4 %)	
I do not know	6 (13.0 %)	

[#] All respondents completing the survey except for one who did not answer; indicates current practices since ACMG recommendations were released [ŧ] All respondents completing the survey; indicates current practices since ACMG recommendations were released [¥] 8/8 indicated that reports of incidental findings are never withheld from the patient [a] Incidental findings

of IFs (Bollinger et al. 2012; Shahmirzadi et al. 2014), some felt that the ability to opt out of these findings should be an option (Ritger et al. 2014; Shahmirzadi et al. 2014; Yu et al. 2014). Additionally, we found respondents felt that consistency of reporting policies among laboratories would be beneficial.

Pre-Test Counseling

Of respondents who were in clinical practice during the integration of the 2013 ACMG recommendations, a majority (61 %) reported that their sessions became longer and many (54 %) reported that the content of their sessions shifted. However, only 23.5 % of respondents reported that their sessions became more challenging. In contrast, 38.2 % felt that counseling about IFs had become easier since the 2013 ACMG recommendations were released. Several respondents expressed that having a list of IFs to discuss with their patients was beneficial.

Patient Autonomy & Testing Children

Consistent with other studies (Bollinger et al. 2012; Shahmirzadi et al. 2014), our survey suggests that most patients want to receive reports of IFs, yet receiving this information should still be optional (Ritger et al. 2014; Shahmirzadi et al. 2014; Yu et al. 2014). The process of genetic counseling is structured to allow patients the opportunity to make medical and reproductive choices based on cultural and/or personal reasons that may not be consistent with what many physicians consider to be in the patients' "best interest" from a medical perspective (NSGC 2006). Thus, some patients find that other life factors may supersede the value of this information (Wilson 2005). Our respondents identified several such examples; patients being overwhelmed with the diagnostic odyssey thus far and wishing to focus on the condition at hand, concerns over a child's future marriage prospects are important in some cultures, and parents not being comfortable submitting their own sample for analysis. In such cases, the only alternative (for those faced with mandatory reporting policies), is to decline this testing altogether and risk not having a diagnosis and subsequent treatment.

Amidst the dialogue surrounding patient autonomy, there has also been discussion regarding IFs in children (Burke et al. 2013; Ross et al. 2013). We found that approximately one third of respondents consider factors such as the age of the minor and the desires of the parents when investigating IFs in children. Surprisingly, a few of these respondents most frequently use laboratories that do not offer the option to opt out of receiving IFs. This appears contradictory; the belief that special consideration should be given to testing minors while sending most samples to testing laboratories that do not offer the option to opt out of receiving IFs. Of note, all respondents who report sending patient samples to labs that do not offer the

option to opt out of receiving IFs also report that they never withhold these findings from patients. This survey did not inquire about contractual obligations between clinics and laboratories or how insurance companies can influence where a sample is sent, which may limit genetic counselors' ability to send their patients' samples to alternate laboratories based on policies for reporting IFs.

In a focus group consisting of physicians, geneticists and genetic counselors, Grove and colleagues (2014) found that "patient autonomy and values should be the primary guide in deciding what results to disclose". Our poll of genetic counselors resulted in similar findings. Shahmirzadi et al. (2014) found a correlation between the severity of presenting symptoms and desire to learn about IFs, which further provides evidence that receiving reports of IFs should be considered on a case-by-case basis, and thus be optional.

Laboratory Reporting

Among those respondents who reported that a laboratory's practice for returning IFs influenced their decision in choosing a laboratory (40 %), a majority reported that the option to opt out of receiving reports of IFs had a significant influence on their decision to send their samples there. This may indicate that a substantial proportion of genetic counselors feel that opting out of receiving reports of IFs should be an option for patients, which is consistent with the ACMG's recent recommendations update (ACMG 2014). Conversely, approximately one third of these respondents reported that the laboratory not offering the option to opt out of receiving IFs had a significant influence on their decision to send their patient's samples there.

Of the 8 respondents who send samples to laboratories that do not offer the option to opt out of receiving IFs, none offer their patients the opportunity to decline receiving this information. Although the numbers are small, we feel that this is a significant observation because it implies that, if the testing laboratory reports IFs to genetic counselors, all of that information will be given to the patients, despite the ACMG's initial recommendation that laboratories should report this information to the ordering clinician, and the clinician and patient can then work together to determine how these results will be reported. This is addressed in the updated recommendations, in that the "recommendations moves the opt out discussion to the point where the sample is sent rather than at the time when results are received by the ordering clinician" (ACMG 2014). Of note, only 3 of these 8 respondents reported that the laboratory not offering the option to opt out of receiving IFs had a significant influence on their decision to send their patients' sample there. This suggests that some of these respondents are reporting this information even when they did not specifically choose a laboratory that mandates reporting of all IFs. Explorations of reasons why genetic counselors may be sending patient samples to such laboratories were not pursued in this survey. Again, this survey did not inquire about contractual obligations between clinics and laboratories or the impact of insurance companies, which may prevent genetic counselors from choosing alternate laboratories based on any other factors.

While not previously anticipated in the literature, several respondents reported that the ACMG recommendations created the challenge of navigating among different laboratories, patients' preferences, and patients' insurance coverage due to differing laboratory policies for reporting IFs and different coverage among insurance policies. According to some respondents, there were times that a choice between laboratories had to be made based on their patient's insurance, even though the laboratory's policies for reporting IFs were not consistent with their patient's wishes for knowing this information. A recent analysis has shown that most, but not all, laboratories are allowing patients to opt out of receiving IFs (Hufnagel and Antommaria 2014). Respondents felt that consistency among all labs for reporting incidental findings would reduce the amount of time spent keeping up to date with current laboratory policies. This confusion regarding differing laboratory policies for reporting IFs, in conjunction with the data indicating that a proportion of genetic counselors feel that receiving reports of IFs should be optional, suggests that having a consistent policy allowing patients to opt out of IFs among all laboratories would be beneficial to patients and clinicians alike.

Limitations

There are several limitations that hinder our ability to make more definitive conclusions from our data. The number of eligible respondents who completed the survey was small; as such we can recognize trends in our data but cannot derive conclusions backed with statistical significance. Logistically, the 2013 ACMG recommendations had been released only 8 months prior to the termination of this study. Thus, genetic counselors' experience with the ACMG recommendations were not extensive so the patient population to which they were referring to was most likely small as well. We cannot eliminate the possibility of a self-selection bias; individuals who had stronger attitudes either for or against the ACMG recommendations may have been more likely to complete the survey, so our sample may not be representative of the population of genetic counselors as a whole. Furthermore, our study targeted genetic counselors only, so we cannot generalize these trends to other medical professionals involved in clinical WES.

Our survey design did not allow us to determine whether multiple respondents came from the same institution. If such a scenario occurred, in conjunction with our small sample size, it could have potentially skewed the data. Additionally, we did not ask how institutional policy on choosing labs for testing

impacts the respondents' ability to choose a testing lab based on patient preferences.

Practice Implications

Our study is among the first to provide empiric data that investigates how genetic counselors have incorporated the 2013 ACMG recommendations for reporting IFs in WES into clinical practice. This study provides a glimpse into challenges faced thus far and can be used in the ongoing discussions surrounding IFs in WES and as an initiation point for further investigations. We were surprised to find that some respondents received no guidance regarding the possibility of mandated reporting of IFs. As the development of policies regarding the return of IFs proceeds, it may be beneficial for clinics to generate a consensus for how they will incorporate new or updated policies as they occur.

Implications for Future Research

There were several interesting findings that were not anticipated during the design of this study; further research regarding these topics may be worthwhile. This study focused solely on the implications of the 2013 ACMG recommendations, and did not inquire about other factors within the healthcare system that can complicate the process. For instance, the interplay of testing cost, insurance coverage and contractual obligations between clinics and laboratories weigh heavily on the decision to send patient samples to one laboratory over another. It would be of interest to explore whether genetic counselors are sending the samples to laboratories whose policies are inconsistent with parents' wishes to learn about IFs, or whether genetic counselors may actively choose to send samples to alternate laboratories in order to preserve parents' wishes to know this information about their children.

Due to the recently released updated ACMG recommendations, it is likely that some testing labs may be in the process of changing their policies regarding the choice for opting out of IFs. The potential influence of ACMG policy recommendations on the testing policies of commercial labs would be an interesting area for future research.

Conclusion

This study aimed to identify some of the major issues that had presented themselves as the 2013 ACMG recommendations began to be implemented. The information obtained may provide an informative basis for discussion in the consideration of future practice guidelines. Although limited in sample size, this study is among the first to present data regarding current practices and opinions of genetic counselors in clinical WES following the release of the 2013 ACMG recommendations. Most respondents welcomed some aspects of the 2013 ACMG recommendations for reporting IFs, such as having a specific list of genes to refer to in discussing IFs with patients. A majority of respondents found that their sessions became longer although not necessarily more challenging. Our data also suggest that policies for reporting IFs should be universal among all laboratories. Consistent with the updated ACMG recommendations, the option to opt out of receiving IFs may be desired in a subset of the patient population. Further investigation in these themes would be beneficial.

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Disclosure This study was completed for partial fulfillment for a Master of Science degree at Brandeis University for author LS. Alicia Braxton, MS, CGC is employed by Baylor College of Medicine Medical Genetics Testing Laboratory, a diagnostic laboratory that offers and derives revenue from clinical WES testing. Authors LS, JD and KK declare that they have no conflict of interest.

Human Studies and Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all participants for being included in the study.

Animal Studies No animal studies were carried out by the authors for this article.

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