Published in final edited form as:

J Genet Couns. 2017 February ; 26(1): 122–132. doi:10.1007/s10897-016-9987-0.

Effect of Public Deliberation on Attitudes toward Return of Secondary Results in Genomic Sequencing

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Abstract

The increased use of genomic sequencing in clinical diagnostics and therapeutics makes imperative the development of guidelines and policies about how to handle secondary findings. For reasons both practical and ethical, the creation of these guidelines must take into consideration the informed opinions of the lay public. As part of a larger Clinical Sequencing Exploratory Research (CSER) consortium project, we organized a deliberative democracy (DD) session that engaged 66 participants in dialogue about the benefits and risks associated with the return of secondary findings from clinical genomic sequencing. Participants were educated about the scientific and ethical aspects of the disclosure of secondary findings by experts in medical genetics and bioethics, and then engaged in facilitated discussion of policy options for the disclosure of three types of secondary findings: 1) medically actionable results; 2) adult onset disorders found in

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Conflict of Interest

The authors have no conflicts of interest to declare.

Human Studies and Informed Consent

All procedures performed in studies involved human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki and its later amendments or comparable ethical standards. This study was deemed exempt from federal regulations by the University of Michigan's Institutional Review Board.

Animal Studies

This article does not contain any studies with animals performed by any of the authors.

children; and 3) carrier status. Participants' opinions were collected via surveys administered one month before, immediately following, and one month after the DD session. Post DD session, participants were significantly more willing to support policies that do not allow access to secondary findings related to adult onset conditions in children (X^2 (2, N = 62) = 13.300, p = 0.001) or carrier status (X^2 (2, N = 60) = 11.375, p = 0.003). After one month, the level of support for the policy denying access to secondary findings regarding adult-onset conditions remained significantly higher than the pre-DD level, although less than immediately post-DD (X^2 (1, N = 60) = 2.465, p = 0.041). Our findings suggest that education and deliberation enhance public appreciation of the scientific and ethical complexities of genome sequencing.

Keywords

ethics; deliberative democracy; surveys; participant preferences; return of secondary genomic results

INTRODUCTION

At present, genomic sequencing—ranging from targeted single gene assays and mutation panels to genome-scale tests such as tumor whole-exome sequencing—is used as a cost-effective alternative to performing multiple diagnostic tests as well as to aid in the diagnosis, treatment, and prevention of genetic conditions not identifiable through conventional molecular testing (Van Allen, Wagle, & Levy, 2013). The goal of integrating genomic sequencing into clinical practice has been, and will increasingly be, to improve how we diagnose and treat diseases. However, this technology also raises complex scientific and ethical issues regarding the disclosure of sequencing results including those secondary to the clinical indication for ordering the test (McGuire et al., 2013; Wolf, Annas, & Elias, 2013). While secondary findings are often of clinical significance, they also can reveal a wide range of health-related conditions where significance is unknown, or further screening or treatments may not exist, creating unintended psychological, social, and medical consequences (Christenhusz, Devriendt, & Dierickx, 2013; Johnston et al., 2012; Kohane, Hsing, & Kong, 2012; Shkedi-Rafid, Dheensa, Crawford, Fenwick, & Lucassen, 2014). As genomic sequencing becomes a standard part of clinical diagnostics, it is imperative that guidelines and policies about how to handle secondary findings be developed.

In an effort to provide guidance on the management of secondary findings, genetic researchers and health professionals' views have been studied (Appelbaum et al., 2015; Grove, Wolpert, Cho, Lee, & Ormond, 2014), advisory panels have been convened (Green et al., 2013), and the Presidential Commission for the Study of Bioethical Issues has provided input (Weiner, 2014). In addition, the American College of Medical Genetics and Genomics has published an official guideline and a recommendation, both of which became sources of controversy within the field as experts debated the extent to which laboratories and clinicians are obligated to report secondary findings, and the conditions under which patients should be able to opt in or out of receiving such results (ABIM Foundation, 2015; ACMG Board of Directors, 2015; American College of Medical Genetics and Genomics, 2013;

Green et al., 2013; Scheuner et al., 2015). As a result, there is no clear consensus on how to guide policy regarding the disclosure of secondary findings.

As experts work towards shaping a national policy, it is also important to take into consideration public viewpoints. The aforementioned debate on the appropriate management of secondary findings from genomic sequencing has not included a high level of public engagement with key stakeholder groups. The issues that surround the return of secondary findings are not exclusively scientific in nature, but are also rooted in concerns regarding the public's values and preferences.

Results of previous research on patient preferences regarding disclosure of secondary findings are inconsistent. Some studies found that members of the public want unrestricted access to their genetic information, even after a comprehensive discussion with a health professional (e.g. genetic counselor) (Bollinger, Scott, Dvoskin, & Kaufman, 2012; Facio et al., 2013; Kaufman, Murphy, Scott, & Hudson, 2008). Other studies suggest that awareness of the potential complexities of testing may shift towards more conservative preferences for genomic sequencing and secondary information. For example, a recent study found that genetic health professionals, who have extensive knowledge and experience with genetic testing, exhibit less desire to learn secondary findings regarding genetic risks for developing serious and preventable conditions relative to laypeople (Middleton et al., 2015). Another study found that among a group of breast cancer patients who received genetic counseling, approximately 30% declined multiplex gene panel testing due to concern about the uncertainty of the results and utility of the information (Bradbury et al., 2015). Additionally, a recent study of three focus groups with individuals who had prior preconception genetic testing experience demonstrated different perceptions of the advantages or disadvantages of screening within each group, suggesting tailored approaches to education, consent, and counseling may be warranted (Schneider et al., 2016). Another focus group on genetic testing involving children highlighted concerns about the return of secondary findings only because of the discussion that occurred in a group context (Christenhusz, Devriendt, Peeters, Van Esch, & Dierickx, 2014). Policy issues related to the disclosure of secondary findings resulting from genomic sequencing involve complex scientific, regulatory, and ethical considerations. The extent to which respondents in these studies considered such complexities prior to articulating their preferences is not known.

Collectively, these studies suggest that simply receiving information about the risks and benefits of genomic testing seems to increase the desire of the lay public to receive secondary findings, while more in-depth knowledge of the complexities of genomic testing, together with group interactions, may modify these views. Further, while these studies highlight shifts in *personal* preferences for receiving secondary findings, it is unclear what laypeople think *public policy* should be regarding the disclosure of secondary findings. Finally, the findings of these studies also underscore that soliciting "public opinion" on issues of health policy cannot be equated with soliciting "*informed* public opinion", as greater knowledge or dialogue seems to temper preferences for receiving secondary findings. Assuming that an informed person provides a more ideal measure of preferences, we should seek to solicit informed public opinion when crafting public policies (Fishkin, 2006; Kim, Wall, Stanczyk, & De Vries, 2009).

One mechanism for the study of informed public opinion is democratic deliberation (DD). This approach begins by educating members of the public on a given topic using presentations delivered by experts with diverse opinions in the field; participants then engage in small group discussions about the issues, after which their *informed* and *collectively considered* opinions are solicited, often through a vote (Fishkin, 2006; Gastil & Keith, 2005; Thompson, 2008). Previous research using DD found shifts in policy preferences and demonstrated that these shifts are not only attributed to participants simply being informed, but also from engaging with one another about the complexities of the issues (Kim et al., 2011). DD methodology has gained traction in bioethics, having been used to elicit public views on cancer screening and consent, biobank development, and surrogate consent for research involving persons with dementia (Kim et al., 2011; McWhirter et al., 2014; Rychetnik et al., 2013; Thomas et al., 2014).

As part of a larger research project (MI-ONCOSEQ) (Roychowdhury et al., 2011) that is integrating somatic and germline sequencing and analysis into clinical oncology practice and examining the psychosocial and ethical issues related to disclosure of genomic results, we conducted a mixed methods DD study between July 2014 and February 2015. The goal of our DD study is to help inform national policy on the disclosure of secondary findings by assessing the informed, well-considered views of the lay public.

MATERIALS AND METHODS

Study design and recruitment

Participants took part in a day-long DD session comprising of educational presentations and facilitated small group discussions. Additionally, they completed three surveys. Survey 1 was administered 1 month prior to the session. Survey 2 was completed immediately following the session. Survey 3 was administered 1 month after the session.

We recruited participants through the University of Michigan Clinical Studies website, a voluntary partnership created for patients and community members to find clinical and health research studies at the University of Michigan [http://UMClinicalStudies.org]. This website is a secure, password-protected recruitment portal that assists researchers in identifying, recruiting, and retaining study participants. Study teams provide basic information about their studies including, purpose, eligibility, what participation involves, and contact information. Potential volunteers visit the website and can sign up for a single study or for a general registry. From this convenience sample, individuals who expressed interest in the study were asked a series of screening questions on age, gender, ethnicity, and personal history of cancer to ensure diversity both in sample characteristics and diversity in participant health related experience. Participants had to be at least 21 years of age. Due to the focus of the MI-ONCOSEQ project on integrating genomic testing into clinical cancer care, we enrolled 38 participants with a personal history of cancer – as indicated in their UM Clinical Studies profile – and 38 without such a reported history. This study was deemed exempt from federal regulations by the University of Michigan's Institutional Review Board.

Procedures

One month prior to the DD session, participants were mailed Survey 1 along with an informational brochure (Brochure S1) and glossary of genomic sequencing terms (Glossary S2) to ensure that all participants had a basic level of understanding of genomic sequencing terminology. The brochure and glossary were developed by the study team and reviewed by an advisory panel consisting of an expert in DD methods, a senior genetics researcher in adult-onset disorders, a bioethicist-sociologist, a pediatrician, a qualitative research expert, and a genetic counselor. These materials were further refined, based on a final systematic review by the members of the advisory panel, additional external experts (in both genetics research and bioethics), and laypersons.

Participants attended a day-long DD session modeled on formats used in prior DD sessions (Kim et al., 2011; Kim et al., 2009) (Table 1). Participants were assigned to one of ten groups, each comprised of 6 to 8 participants. The groups were organized into three categories: participants with a personal history of cancer (3 groups), participants without a personal history of cancer (3 groups), and mixed (4 groups). We oversampled participants with personal and family histories of cancer because a significant proportion of secondary findings from genomic sequencing that are medically actionable pertain to cancer risk, and therefore policies in this area are likely to be particularly salient for this subgroup (ACMG Board of Directors, 2015). A trained facilitator moderated the discussion at each table. Each facilitator had a background in either genetic counseling or health education and received two hours of DD facilitator training from a study team investigator with expertise in qualitative research and in the conduct of DD sessions, consistent with training procedures for other published studies using this methodology (Kim et al., 2009). Experts and members of the study team were available to field questions that emerged during the small group discussions throughout the day. At the end of the session, attendees were asked to complete Survey 2. The follow-up survey (Survey 3) was administered one-month following the session. Participants received $150 for attending the session and completing all three surveys.

DD session presentations—We developed two 35-minute educational presentations. The first, entitled “What can we learn from sequencing our genes?” described the science and technology behind genomic sequencing. The second, “Ethical issues in sequencing our genes,” offered an introduction to the bioethical issues that attend genomic medicine. The presentations were developed using an iterative process between study team members, the advisory panel, and the expert presenters; among the goals was to provide our DD attendees with a balanced presentation of the pros and cons and benefits and risks of this new technology in an effort to minimize bias to the best of our ability. These two presentations were followed by an explanation of proposed policies regarding the return of secondary findings when these findings revealed medically actionable results, adult-onset conditions, and carrier status (Table 1).

Small group voting—In their small groups, participants were asked to discuss, and then vote on, the proposed policy for each of the three situations. The question they were asked was, “Should this be the genomic sequencing policy regarding the return of secondary

findings with information about [medically actionable conditions/adult-onset conditions/carrier status]?" The main purpose of the voting was to enhance discussion by encouraging people to take and defend a position on the proposed policies.

Study Materials

Surveys—The study team developed the three surveys (baseline, post-deliberation, and follow-up) based on a literature review and an iterative process between the advisory panel and study team members (Table 2 and Survey S3).

Survey 1: Baseline assessment

Attitudes towards proposed policies: Participants were asked to reflect on three proposed policies for the return of secondary findings identified through genomic sequencing. The policies were based on a review of the literature and current medical practice. The survey included proposed policies for 1) medically actionable results; 2) childhood disclosure of adult-onset conditions to parents; and 3) carrier status for autosomal recessive conditions. The first part of each policy presented the default disclosure procedure according to current standards of care in genetic medicine (e.g., whether the results would be identified and returned to patients) and the second part outlined whether the default position was flexible (e.g., whether patients have a choice about whether they could receive or decline information about secondary findings) (Table S4).

Following the description of each policy participants were asked, using a 6-point scale ("definitely no" to "definitely yes"), if ***they would personally want*** to receive secondary findings. Participants were also asked whether the proposed policy would be appropriate for ***society as a whole***. Participants were then asked whether they agreed or disagreed with the default and/or flexibility of each policy.

Experience with and knowledge of genetics: Participants were asked about their previous experience with genetics. The survey included 9 questions that tested key genetic concepts explained in the informational brochure participants received with Survey 1 (see Brochure S1). These questions were asked to establish baseline and sustained knowledge of basic concepts of genomic sequencing. Participants were also asked four subjective knowledge questions (on a 5-point scale).

Information needed to inform a decision to undergo genomic sequencing: Participants selected how much and what types of information they would want in order to feel sufficiently informed before making a decision about whether to undergo genomic sequencing. If participants indicated that they wanted additional information about the conditions being tested, they were then asked to select what specific details they would want to know by checking "all that apply" (see Survey S3). Participants also indicated what sources of information (e.g., the internet; health care provider) they would use to find out information to make a decision.

Demographics: Participants were asked to complete standard demographic questions.

Survey 2: Post-deliberation assessment: Survey 2 included the same measures of attitudes towards proposed policies, experience with and knowledge of genetics, and information needs and sources used in Survey 1, as well as a DD session evaluation.

DD session evaluation: The DD session evaluation measured general satisfaction with the DD session, whether the session changed their understanding and/or attitudes about genomic sequencing, how helpful the session was for answering policy questions in the survey, and an open-ended question about what they liked/disliked about the session.

Survey 3: Follow-up survey: Survey 3 included the same measures of attitudes toward proposed policies, experience with and knowledge of genetics, and information needs and sources used in Survey 1 and 2 (see Survey S3).

Analyses

The participant characteristics of individuals with and without a personal history of cancer were compared using independent-samples t-tests for interval data variables and chi-square tests for categorical variables. For policy preferences, we analyzed responses on both the 6-point scale and as dichotomized versions (“agree” and “disagree”) with similar results. Here we report the dichotomized versions of participant responses’ regarding policy preferences for ease of interpretation. We also examined aggregate level policy preferences (grouping individual level responses by assigned small group) for the three proposed policies to see if there were any group level effects. Within-subject responses across the three survey time points were analyzed using paired-sample t-tests for interval data and Cochran’s Q Test to determine any differences on dichotomous dependent variables between the three survey time points. Analyses were conducted using SPSS v.22.

RESULTS

We posted information about our study on the website, UMClinicalStudies.org. 265 people expressed interest in participating in this study. Of those 265 interested individuals, we invited 94 to participate based on a range of demographic criteria (e.g., age, gender, ethnicity, personal history of cancer). Ultimately, 76 invitees decided to enroll in the study.

Surveys

Of the 76 participants enrolled in the study, 70 completed Survey 1 (response rate = 92%), 66 attended the day-long DD-session and completed Survey 2 (87%), and 64 DD session attendees completed follow-up Survey 3 (84%).

Demographics—Of the 64 participants who attended the DD session and completed all three surveys, 44 (68.8%) participants had a family history of cancer, as self-reported on Survey 1, and 38 had a personal history of cancer, as indicated in their UM Clinical Studies profile. The average age of participants was 57.3 (SD = 14), 70.3% were female, and 21.9% identified as being non-white. Participants tended to be highly educated, with 40.6% having a post-bachelor’s degree (Table 3).

Experience with and knowledge of genetics—The majority (81.3%) of respondents reported hearing of genomic sequencing prior to participating in the study. Eight (12.5%) indicated that they previously had genetic testing ordered by their doctor. Participants correctly answered almost all of the 9 baseline questions testing key genetic concepts in the informational brochure (M = 8.0, SD = 1.0, range=3–9), which was reflected in the high self-reported confidence (M = 4.0, SD=0.8, range=2–5) and understanding (M = 3.9, SD=0.9, range=2–5) of genetic information. Despite this, subjective and comparative knowledge of genetics were average (M = 3.1, SD=1.0, range=2–5 and M = 3.5, SD=0.8, range=2–5) (Table S5).

Attitudes towards proposed policies—Table 4 shows the effect of deliberation on participant support for the proposed policies for the return of secondary findings across the 3 survey time points—including support for the policy *overall*, the *default* (whether results are given or not given), and the policy's *flexibility* (whether there is a choice). At baseline, an overwhelming majority (89.1%) agreed with the proposed societal policy for medically actionable results where patients are given medically actionable results that are unrelated to the reason for the sequencing, and they can ask to not be given these results. For this policy, responses remained unchanged across all three surveys (X^2 (2, N = 62) = 1.412, p = 0.494). A minority (9.4% and 4.7%, respectively) of participants agreed at Survey 1 with the proposed policy for adult-onset conditions where children and their parents are *not* given results for adult-onset conditions unrelated to the reason for the sequencing and are *not* given these results even if they want them (9.4% for the policy overall), as well as the policy for carrier status where patients are *not* given carrier status results unrelated to the reason for the sequencing and are *not* to be given these results even if they want them (4.7% for the policy overall). Across all three surveys, we detected a significant change in the proportion of individuals that agreed with both the policy on adult-onset disorders (X^2 (2, N = 62) = 13.300, p = 0.001) and carrier status (X^2 (2, N = 60) = 11.375, p = 0.003). For example, agreement with the adult-onset disorders policy increased from 9.4% to 43.8% at the post-DD session assessment, while agreement with the carrier status policy increased from 4.7% to 21.9%.

Given the significant change in the proportion of individuals that agreed with the policies on testing children for adult-onset conditions and testing for carrier status across all three surveys, pairwise multiple comparisons were examined by applying Cochran's Q test (adjusted for multiple comparisons). After the DD session (Survey 2), there was a significant increase from baseline in the proportion of participants who agreed with the overall proposed policy on returning secondary findings to parents and children for adult-onset conditions (X^2 (1, N = 62) = 3.560, $p \leq 0.001$), the default part of the policy (X^2 (1, N = 60) = 3.935, $p \leq 0.001$) and that they are not given these results even if they want them (X^2 (1, N = 57) = 3.320, p = 0.003). There was also a significant increase from baseline in the proportion of participants who agreed with the proposed policy on carrier status, overall (X^2 (1, N = 60) = 3.062, p = 0.007), but not the default or flexibility portions. At follow-up (Survey 3), the increases in support for testing children for adult-onset conditions remained statistically significant for the overall policy (X^2 (1, N = 60) = 2.465, p = 0.041), as well as the default (X^2 (1, N = 57) = 2.546, p = 0.033) and the no choice portions of the policy (X^2

(1, N = 57) = 2.554, p = 0.032). Views on the proposed policy for carrier status results returned to baseline at Survey 3, dropping from 21.9% support to 7.8%. Notably, across all three surveys, a strong majority disagreed with the "no choice" portion of the policies both for adult-onset conditions (ranging from 67.2% to 89.1%) and carrier-status (ranging from 84.4% to 93.8%).

Participants' personal preferences for the return of secondary findings mirrored the shifts in societal policy preferences. However, it is worth noting that individuals' personal preferences did not perfectly map onto their societal policy preferences. Across all three surveys, anywhere from 8.0%–23.1% of the participants had a policy preference that differed from their personal preference. For example, nearly one-fourth of participants (23.1%) agreed with the proposed policy that would *not* allow children and parents to be given results for adult-onset conditions unrelated to the reason for sequencing the child's genome but said that *they* would want to be told whether their child had an increased risk of developing an adult-onset condition.

Information needed to inform the decision to undergo genomic sequencing— At Survey 1, 34 participants (53.1%) indicated that they wanted detailed information about every condition being tested before agreeing to have their genome sequenced. Seventeen (26.6%) responded that they wanted to learn about all of specific types of "detailed information" that we listed (Table S6). After the DD session (Survey 2), the number of participants who indicated they wanted the detailed information about every condition marginally decreased (from 53.1% to 39.4%), (X^2 (1, N = 62) = 0.125, p = 0.264, adjusted), but was significantly less (from 53.1% to 30.3%) at follow-up (X^2 (1, N = 62) = 0.219, p = 0.009, adjusted).

DD session evaluation—Overall, participants had positive views of the DD session. Participants felt their opinions were respected, the process was fair, and they were willing to abide by the policy decision put forth by the group (Table S7). Participants also reported that attending the session increased understanding about some of the outcomes that can occur as a result of genomic sequencing (M = 4.5, SD = 0.6, range=1–5). Participants did not report a significant change in their attitudes towards using genomic sequencing for medical purposes (M = 3.9, SD = 0.9, range=1–5).

DISCUSSION

A significant ethical challenge of precision medicine is deciding what to do with secondary findings from genomic sequencing. Policy options should be informed by public opinion, but the complexity of genomic medicine makes it difficult to learn what members of the public want done with these findings. To address this challenge we used a proven method of structured education and deliberation to inform citizens of the complex scientific and ethical issues associated with secondary findings and to solicit their *informed* and *considered* policy preferences.

Our study shows the limitations of relying on surveys alone to measure public opinion about the disposition of secondary findings. If policy makers were to use the results of our initial

survey (Survey 1) to determine the best approach for the return of secondary findings, they would likely recommend that all results be returned by default with a choice to opt out. Although still in the minority, as we saw in Surveys 2 and 3, education and deliberation altered the opinions of many participants, making them more willing to consider an overall policy where results are not returned by default with no opt-in for adult-onset conditions in children and carrier status. The deliberative session enhanced the public's appreciation of the complexities of genomic medicine and opened the door to previously unconsidered and opposing viewpoints. However, it should also be noted that many participants' views at the one-month follow-up had reverted back to their baseline preferences, perhaps suggesting that the effects of deliberation may diminish over time if not supplemented by further consideration of policy options.

Our study is also informative in two other respects. First, we learned that participants were somewhat less concerned about what the default policy was in terms of receiving/not receiving secondary findings than with the preservation of a ***choice*** to receive/not receive findings (e.g. flexibility of the policy). This accounts for the differences between participant attitudes toward the policy on medically actionable findings – which allowed for the choice to receive or refuse results – and the other policies, which did not allow choice. The public places a high value on choice, but this value was tempered by education and deliberation, resulting in increased support for policies that restricted choice and decreasing the desire for detailed information about every condition being tested. Further analysis of our qualitative data, including responses to open ended survey questions and transcripts of the DD sessions, will shed light on the underlying rationales behind the public's attitude toward the limits of choice. Second, we learned that there is a difference between what people want for themselves (to receive/not receive information) and what people prefer as societal policy. Our data, in concert with other research findings (Stone, Choi, de Bruin, & Mandel, 2013; Ubel, Angott, & Zikmund-Fisher, 2011; Zikmund-Fisher, Sarr, Fagerlin, & Ubel, 2006) indicate a sizeable minority of people may have policy preferences that differ from their personal preferences, suggesting we cannot infer the public's support or opposition to genomic sequencing policies from findings regarding ***only personal*** preferences.

Study Limitations

This was an exploratory study with the intent to help shape national health policy on the disclosure of secondary genomic findings by soliciting informed public opinion using a novel methodological approach. The recruitment strategy was deliberately designed to maximize the likelihood of a diverse study sample, rather than a sample representative of the population as a whole; therefore, conclusions are not meant to be inferential. Although there was high internal validity, the external validity may be limited by the small self-selected sample. For example, our population was highly educated and, therefore, results may not be representative of more diverse populations. Given our short (1 month) follow up time and limited sample size, larger prospective, longitudinal studies to evaluate differences by subgroups are needed. While we were unable to measure whether the education or the deliberation component of the DD session was the mechanism responsible for the shift in participants' perspectives, other research using DD methodology found that education alone does not account for shifts in perspective (Kim et al., 2011). Given the complexity and

novelty of both the scientific and ethical issues that surround genomic sequencing, it is also not surprising that there was some shift back towards baseline in the 1 month follow-up survey. The shift towards baseline responses could also be due to a "recency effect", in that they just participated in a day long education and deliberation session, thereby biasing responses in favor of the policy on Survey 2. The shift may also reflect an anchoring and adjustment bias that has been observed in other health psychology studies, whereby individuals may initially alter their beliefs in response to new information (e.g., disease risk estimates), only to have these beliefs drift back toward their initial "anchoring" point over time. Similar results have been reported that suggest the anchoring and adjustment bias exists across multiple disease types and risk groups (Gurmankin, Domchek, Stopfer, Fels, & Armstrong, 2005; Linnenbringer, Roberts, Hiraki, Cupples, & Green, 2010; Weinstein et al., 2004).

Policy Implications and Research Recommendations

Our results may have significant policy implications given that the value of secondary findings remains debatable. While they are often of clinical significance, they also may result in unintended psychological, social, and medical consequences. Our study shows strong support for a policy where medically actionable findings unrelated to the reason for sequencing are disclosed by default, and that patients have a choice about whether they receive these results. We also show there was little support for policies where results for adult-onset conditions in children and carrier-status are not given by default and there is no choice about disclosure. However, as citizens become more informed and have discussions with their fellow citizens they become significantly more supportive of these more restrictive policies. Translating levels of public support into policy can be challenging. Nevertheless, it may be useful for institutional review boards, other research oversight bodies, and future policy-making panels to know what happens when citizens are provided an opportunity to learn and deliberate about the complex ethical and scientific issues regarding of the return of secondary findings in genomic sequencing.

Further, while our study was focused on preference for policies regarding secondary findings, the results also reflect the importance of pretest counseling since individual preferences seemed to change with deliberation.

Finally, our study also demonstrates the feasibility of a DD approach for obtaining high quality feedback from the public on policy issues that involve complex ethical and scientific dimensions. Most importantly, this research confirms the need to seek *informed* and *considered* public opinion about societal policies on these complex disclosure issues.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors would like to thank all of the individuals who participated in this study, including the external advisors, DD session facilitators, and presenters Drs. Robert Green and Wylie Burke. The work was supported by the National Human Genome Research Institute Clinical Sequencing Exploratory Research Consortium grant

1UM1HG006508. The sponsor had no role in the study design, collection, analysis, or interpretation of data; writing of the report; or the decision to submit paper for publication. The ideas and opinions expressed in this paper do not represent any position or policy of the National Institutes of Health, the Department of Health and Human Services, or the U.S. government.

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Table 1

Overview of DD session

Plenary Introduction	Overview of the agenda for the day
Small Group: Session 1	Ice breaker exercises
	Video, "Whole Genome Sequencing and You"[1]
	Discussion focusing on reactions to the video
Expert Presentations	Each presentation lasted 50 minutes, including a 15 minute question and answer session.
	Presentation 1: *"What can we learn from sequencing our genes"*
	Presentation 2: *"Ethical issues in sequencing our genes"*
Small Group: Session 2	Participants were given a chance to reflect upon and discuss the 2 presentations and general thoughts on genomic sequencing. (30 minutes)
Policy Presentation	Explanation of proposed policies regarding return of secondary findings in 3 situations – **medically actionable results, adult-onset conditions,** and **carrier status.** For each policy, participants were asked to consider "Should this be the genomic sequencing policy?"
Small Group: Session 3	Discuss & vote on proposed policy: "Patients are given **medically actionable results** that are not related to the reason for the sequencing. Patients have a choice: They can ask to NOT be given these results." (30 minutes)
Small Group: Session 4	Discuss & vote on proposed policy: "Children and their parents are not given results **for adult-onset conditions** that are not related to the reason for the sequencing. Children and their parents have no choice: They will not be given these results even if they want them." (30 minutes)
Small Group: Session 5	Discuss & vote on proposed policy: "Patients are not given **carrier status results** that are not related to the reason for the sequencing. Patients have no choice: They will not be given these results even if they want them." (30 minutes)

[1]

Table 2

Measures by Survey

	Baseline	Post-DD	Follow-up
Individual characteristics			
Participant demographics	X		
Genetic and family history experience	X	X	X
Changes to health/genetic testing			X
Exposure to genetics in media			X
Policy opinions			
Personal & societal policy views	X	X	X
Willingness to pay	X	X	X
Risk assessment	X	X	X
Knowledge and understanding			
Genetics Concepts	X	X	X
Definition of medically actionable		X	
Steps in genome sequencing			X
Information Needs			
Information needed for decision-making	X	X	X
Sources for information	X	X	X
Deliberation Evaluation			
General satisfaction		X	
Change to understanding/attitudes		X	
Helpfulness for deciding on policies		X	

Table 3

Participant Characteristics (n=64)[a]

	n (%)[b]
Gender	
Female	45 (70.3)
Male	19 (29.7)
Age, Mean (SD)	57.3 (14)
Ethnicity (“mark all that apply”)	
White	50 (78.1)
Black	11 (17.2)
American Indian or Alaskan Native	4 (6.3)
Asian	2 (3.1)
Hispanic	2 (3.1)
Middle Eastern/Arab	1 (1.6)
Other	1 (1.6)
Education[1]	
High school or less	4 (6.3)
Some college/college/trade school	33 (51.6)
Graduate degree	26 (40.6)
Have children or not	
Yes	43 (67.2)
No	18 (28.1)
Annual household income	
Below $40,000	16 (25.0)
$40,000–$79,999	28 (43.8)
More than $80,000	17 (27.0)
Health status	
Poor	1 (1.6)
Fair	7 (10.9)
Good	20 (31.3)
Very good	19 (29.7)
Excellent	12 (18.8)
Had genetic testing ordered by a doctor	
Yes	8 (12.5)
No	56 (87.5)
Have family history of …	
Cancer	44 (68.8)
Heart disease	37 (57.8)
Neurological disorder	12 (18.8)

[a] Included are all participants who attended DD session and responded to all three surveys. No significant differences between participants with/without a personal history of cancer were detected.

[b] Some percentages do not add to 100 because not all participants answered the question.

Table 4

Effect of democratic deliberation on attitudes toward policies for secondary findings, n = 64[a]

	Baseline (Survey 1)			Post-DD session (Survey 2)			Follow-up (Survey 3)		
Proposed Policy	**Overall**	**Default**	**Choice**	**Overall**	**Default**	**Choice**	**Overall**	**Default**	**Choice**
Medically actionable									
Patients are given medically actionable results that are not related to the reason for the sequencing. Patients have a choice: They can ask to NOT be given these results.									
%Agree	89.1	81.3	87.5	85.9	89.1	95.3	93.8	89.1	87.5
%Disagree	9.4	17.2	10.9	12.5	10.9	4.7	6.3	9.4	9.4
Adult-onset conditions									
Children and their parents are not given results for adult-onset conditions that are not related to the reason for the sequencing. Children and their parents have no choice: They will not be given these results even if they want them.									
%Agree	9.4	20.3	7.8	*43.8[a]*	*50.0[a]*	*31.3[b]*	*23.4[a]*	*39.1[a]*	*25.0[b]*
%Disagree	87.5	76.6	89.1	*54.7[a]*	*50.0[a]*	*68.8[b]*	*73.4[a]*	*57.8[a]*	*67.2[b]*
Carrier status									
Patients are not given carrier status results that are not related to the reason for the sequencing. Patients have no choice: They will not be given these results even if they want									

Proposed Policy	Baseline (Survey 1)			Post-DD session (Survey 2)			Follow-up (Survey 3)		
	Overall	Default	Choice	Overall	Default	Choice	Overall	Default	Choice
them.									
%Agree	4.7	14.1	4.7	*21.9*[a]	*31.3*	*15.6*	*7.8*	23.4	6.3
%Disagree	98.4	84.4	93.8	*75.0*[a]	*68.8*	*84.4*	*90.6*	73.4	90.6

[a] $P \leq 0.01$; The p value is based on related samples Cochran's Q test, compared to baseline (Survey 1) response, adjusted for multiple comparison. Not all participants answered the question.

[b] $P \leq 0.05$; The p value is based on related samples Cochran's Q test, compared to baseline (Survey 1) response, adjusted for multiple comparison. Not all participants answered the question.