

Adolescent Medical Providers' Willingness to Recommend Genetic Susceptibility Testing for Nicotine Addiction and Lung Cancer Risk to Adolescents

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Objective To examine the influences of disease, lifestyle, and other factors on adolescent medical providers' willingness to recommend genetic susceptibility testing (GST). **Method** Providers attending a national conference completed a self-report survey ($n = 232$) about their willingness to recommend hypothetical GSTs, differentiated by disease (nicotine addiction/lung cancer), patient lifestyle (nonsmoker/smoker), and other contextual factors. **Results** Compared to recommending GST unconditionally, providers were more willing to recommend GST with parental/patient consent/assent, and in the presence of a preexisting illness and substance abuse history. Compared to offering nicotine addiction GST to a nonsmoker, providers were more willing to offer this type of testing to a smoker and were more willing to offer GST for lung cancer regardless of patient lifestyle. **Conclusions** Providers' willingness to recommend GSTs is sensitive to many factors. Efforts to integrate GST into adolescent preventive care likely will need to address these and other influences on provider behavior.

Key words adolescents; chronic disease; genetics; prevention; smoking.

Introduction

Each year, more than 400,000 Americans die from cigarette smoking, making it the single most preventable cause of premature death in the US (CDC, 2005). One way to reduce the morbidity and mortality associated with tobacco use is to intervene with young people through primary, secondary, or tertiary prevention efforts (Sargent & DiFranza, 2003; Vickers et al., 2002). Several expert panels and professional organizations dedicated to the health and well-being of children and adolescents note that providers should integrate and emphasize issues of disease prevention and control into their clinical practice, including tobacco control (AAP, 2001; USPHS, 2000).

The genetics of smoking behavior and smoking-related disease may be yet another tool to augment prevention efforts. In 2006, the Centers for Disease Control and Prevention sponsored a workgroup meeting to discuss

the role of family medical history in pediatric primary care and public health, including its use as a tool for prevention (Green, 2007). Workgroup members referred to an accurate family history as the "gateway to the molecular age of medicine" (Trotter & Martin, 2007), as it encompasses the complex interactions of genes and lifestyle that may someday characterize genomic testing. The results of the workgroup meeting highlight the use of family history as a tool for preventive medicine, for major chronic diseases, for early signs of diseases, and the behaviors evidenced early in life that may underlie them (Valdez et al., 2007).

Despite the promise that utilizing an accurate family history could offer, this approach faces many of the same barriers that integration of new genomic technologies will likely face, including provider time, knowledge, and attitudes (Green, 2007; Guttmacher, Porteous,

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& McInerney, 2007). Evidence suggests that providers, including pediatric and adolescent medicine providers, express some ambivalence when considering the integration of genomics into tobacco control services, seeing both its risks and benefits (Park et al., 2007; Tercyak et al., 2007). While providers believe that genetically tailored treatment may offer new hope to smokers trying to stop smoking, they also voice concern regarding patients' misinterpretation of genetic test results and the potential for discrimination. In a recent survey of American Medical Association members, primary care physicians expressed enthusiasm for the ability to match smoking cessation treatment to a patient's individual genetic characteristics and the potential that such tailoring may be a source of encouragement for patients. However, providers expressed reservations regarding potential discrimination and stigma when considering that genotypes used to tailor treatment may also be associated with other comorbidities (Levy et al., 2007). In addition to concerns about discrimination, there are additional concerns related to the potential for heightened distress in the face of a high risk result or demotivation in response to a lower risk result (Carlsten & Burke, 2006). To someday achieve a full integration of genomics into pediatric preventive care will require a better understanding of specific disease, lifestyle, and contextual factors that may promote or compromise such efforts.

The application of genetic susceptibility testing (GST) to smoking behavior and its disease sequelae will most likely assume two major forms: nicotine addiction GST and GST for smoking-related diseases (such as lung cancer), and different aspects of these tests may differentially impact provider behavior. Evidence continues to mount regarding the role of genetics in nicotine addiction susceptibility and dependence. Specifically, gene variants related to the dopaminergic and serotonergic pathways, as well as those associated with nicotine metabolism, appear to influence addictive processes (Lerman & Berrettini, 2003). There has been some recent success in the area of pharmacogenomics for smoking cessation (David et al., 2007; Lerman et al., 2003; Swan et al., 2005), though additional trials are needed prior to translation into practice settings (Lerman et al., 2007).

Evidence also exists for cancer susceptibility testing, notably lung cancer GST (Amos et al., 2008; Hung et al., 2008; Thorgeirsson et al., 2008). Several genes that are involved in the metabolism of nicotine and detoxification of lung cancer-causing carcinogens in cigarette smoke, as well as tumorigenesis, have been identified (Amos, Caporaso, & Weston, 1992; Caporaso et al., 1989; Law, Hetzel, & Idel, 1989; Mannervick, 1985). Several trials

have been conducted among adult smokers that have integrated GST (Ito et al., 2006; Lerman et al., 1997; McBride et al., 2002), though to date, neither the epidemiological nor the behavioral evidence exists to integrate this information into clinical care (Perera et al., 2007; Schneider et al., 2004).

The application of genetics to the study of smoking behavior, and the clinical applications that may develop as a result, has been contested in recent years (Bierut et al., 2007; Carlsten & Burke, 2006), and several issues need to be addressed before any such innovations are discussed with patients (Park et al., 2007; Shields et al., 2004). As mentioned, physician attitudes towards these applications have been mixed. A previous report of adolescent medical providers' attitudes toward GST for nicotine addiction indicated modest enthusiasm among providers, and that enthusiasm was influenced by their typical tobacco screening behaviors and optimism in biobehavioral research (Tercyak et al., 2007). Primary care physicians have been known to express more reticence when considering tailoring smoking cessation treatments based on the results of a genetic test as compared to tailoring based on a test result that is not specifically described as "genetic" (but rather as a "serum protein test") (Shields et al., 2005). This suggests specific concerns about the incorporation of genetics into practice that might not otherwise occur for other, newer technologies.

The increasing probability that genomics and lifestyle will be combined to facilitate an understanding of risks for common diseases suggests that such factors should be explored among providers to simulate their clinical impact. Particular areas to be examined include whether providers view the application of genomic susceptibility as most appropriate for primary versus secondary prevention (i.e., for nonsmokers or those who experiment with smoking), for immediate versus distal health outcomes (initiation of a cancer-causing addictive process vs. cancer), or under particular clinical conditions that providers are most likely to encounter and must ultimately resolve (issues of informed consent, testing cost, professional consultation, and comorbidity) (Guttmacher & Collins, 2005; Guttmacher et al., 2007; McBride & Brody, 2007; Thompson, 2007).

In light of these issues, the purpose of the present study was to examine the relative influences of disease, lifestyle, and other factors on adolescent medical providers' willingness to recommend GST to their adolescent patients. Disease influence was examined from two perspectives: the onset of an immediate health outcome that is linked to a more distal health outcome (nicotine

addiction GST), or the onset of a more distal health outcome only (GST for lung cancer). Lifestyle influence was examined by patient smoking status (smoker, nonsmoker). Contextual factors included willingness to offer GST: unconditionally, with parental/patient consent/assent, after consulting a genetics expert, even if not covered by patient insurance, with a preexisting chronic illness, such as asthma, and with a preexisting substance abuse history. It was hypothesized that providers would be more willing to recommend GST for an immediate health outcome, among smokers, and that contextual factors would play significant roles. Specifically, there would be more willingness among those expressing greater optimism about behavioral research in this area, greater knowledge about and interest in counseling patients about genetic testing, and among providers with fewer years in practice and those in academic medical settings.

Methods

Participants and Procedure

A complete description of the study sample and data collection procedures are described in a previously published report (Tercyak et al., 2007). Briefly, the survey was distributed in March 2005 at the annual scientific conference of the Society for Adolescent Medicine (SAM). During this conference, trained research assistants approached conference attendees (identified by their conference badges) in the meeting registration area to complete an anonymous and confidential 10-min survey regarding adolescent medicine providers' tobacco control practices. Upon returning the completed survey during the conference (56%), respondents were offered a \$5 gift certificate to a media store to acknowledge their time and participation. This study was reviewed and received an exemption from the institutional review board of the host institution. The Society of Adolescent Medicine also reviewed and approved the study for administration at their conference.

Genetic Susceptibility Testing Scenarios

While the use of hypothetical scenarios comes with some disadvantages (such as not necessarily reflecting eventual behavior; Lerman et al., 2002), this approach remains an important tool to examine issues related to GST (Persky et al., 2007). Most previous studies have assessed provider attitudes towards genetic testing and behavioral intentions, rather than assessing the numerous complexities that might influence provider attitudes and behavior when applied to clinical practice (Freedman et al., 2003; Park et al., 2007; Tercyak et al., 2007). In the current study, a series of hypothetical scenarios were designed to allow for

comparisons within and across two different GSTs, by patient smoking behavior, and under different clinical circumstances.

Survey respondents first were presented with two short clinical scenarios. These scenarios provided information about the GST, its effectiveness, and pertinent family history of smoking. Each scenario varied the purpose of the GST. In the case of nicotine addiction, the scenario read as follows:

Suppose that a gene variant is discovered that is strongly correlated with maintenance of smoking behavior (i.e., addiction). Genetic testing for this variant is highly accurate and affordable. You have a 13 year-old patient named Jamie and both of Jamie's parents are heavy smokers.

In the case of lung cancer, the scenario read as follows:

Suppose a gene has just been identified that, when mutated, confers a very high risk of lung cancer. Genetic testing for mutations in this gene is highly accurate and affordable. You have a 13 year-old patient, Pat, and both of Pat's parents are heavy smokers.

Dependent Variables

Respondents then were asked to complete six items that altered the clinical circumstances under which providers' willingness to recommend GST was queried (unconditionally, with parental/patient consent/assent, after consulting a genetics expert, even if not covered by patient insurance, with preexisting chronic illness, with preexisting substance abuse history), and did so within the context of the patient being a nonsmoker (*I would recommend testing for this variant to Jamie/Pat if Jamie/Pat does not smoke . . .*) and then within the context of the patient being a smoker (*I would recommend testing for this variant to Jamie/Pat if Jamie/Pat has begun smoking . . .*). Response categories were given on a five-point Likert scale ranging from *strongly agree* to *strongly disagree*; these were then collapsed into two categories (*strongly agree/agree* vs. *neutral/disagree/strongly disagree*). All respondents completed all scenarios, which were not counterbalanced due to the setting in which data were collected.

Covariates

Demographics and Clinical Practice Information. Survey respondents reported their age, gender, race, professional affiliation and training, the number of patients seen per week, and practice setting.

Research Optimism. A multipart item was used to measure respondents' optimism that biobehavioral research would lead to improvements in adolescent smoking prevention and treatment (two items) and that genetic research would lead to significant improvements in the prediction of the development and treatment of complex traits such as smoking behavior (two items), using a four-point Likert scale (*not at all—very much so*) (Tercyak et al., 2007). The sum of these Likert items served as an overall research optimism score (range = 4–16; Cronbach's $\alpha = .71$).

Interest in Counseling Patients. Respondents indicated their interest in counseling patients about genetic testing related to smoking behavior, prevention, and cessation using a Likert scale (1 = *not at all* to 4 = *very much so*) collapsed into two categories (*very much/moderately so vs. somewhat/not at all*).

Knowledge about Counseling Patients. Respondents indicated how knowledgeable they were in counseling patients about genetic testing related to smoking behavior, prevention, and cessation using a Likert scale (1 = *not at all* to 4 = *very much so*) collapsed into two categories (*very much/moderately so vs. somewhat/not at all*).

Data Analysis

Analyses were conducted in the following steps. First, descriptive statistics for all study variables were calculated, and their distributions were examined for outliers and missing data. Second, to identify potential covariates for further inclusion in multivariable models, we entered each covariate (out of the 11 considered) one at a time into separate logistic regression models with generalized estimating equations (GEE) to evaluate their ability of predicting the dependent binary responses. GEE methods with an exchangeable working correlation structure were used to account for the correlations among responses offered by the same respondent (Fitzmaurice et al., 2004; Zeger & Liang, 1986). Statistically significant covariates (i.e., those with Bonferroni adjusted $p < .05$ [or equivalently, with $p < .05/11 = 0.0045$]) were included in subsequent multivariable models. Finally, unadjusted and adjusted odds ratios (ORs) were calculated from logistic regression models with GEE to quantify the role of GST, patient smoking behavior, and clinical circumstances, with and without adjustment for covariates. We assessed for the presence of a three-way interaction between GST type, patient smoking behavior, and clinical circumstances. To describe the interaction, we have evaluated the effect of each clinical circumstance within each combination of GST type and patient smoking status, and also (for completeness) the effect of each combination of GST type and patient smoking status within each clinical circumstance.

More specifically, we calculated ORs corresponding to comparisons between the four combinations of GST/patient smoking behavior (addiction/nonsmoker, addiction/smoker, lung cancer/nonsmoker, and lung cancer/smoker) within each clinical circumstance, and also for comparisons between clinical circumstances within each combination of GST/patient smoking behavior. The logistic regression models with GEE were fit using PROC GENMOD from SAS 9.1 (SAS Institute, Inc., Cary, NC, USA).

Results

Demographics, Clinical Practice Information, and Scenario Frequencies

Most survey respondents were females (68%), physicians (62%), whites (72%), and employed within academic medical settings (73%). Mean age was 42 (range = 25–64). As a group, they reported being in practice for 10 years, with 53% reporting having been in practice for at least 6 years. Respondents reported seeing, on average, 43 patients per week, with 56% seeing at least 30 patients per week. Fourteen percent indicated that they had received formal training in clinical genetics. They expressed mild research optimism ($M = 9.7$, $SD = 4.4$) and interest in counseling patients about genetic testing related to smoking behavior, prevention, and cessation ($M = 1.86$, $SD = 0.8$), but low levels of knowledge ($M = 1.23$, $SD = 0.5$). As shown in Table I, there was great variability in the willingness to offer testing across scenarios. For example, willingness to offer GST for nicotine addiction for nonsmokers was quite low (16%), though willingness to offer testing in the presence of preexisting conditions was considerably higher (61–70%).

Bivariate Analyses

Relationships between covariates and the binary responses were examined using logistic regression models with GEE. After adjusting for multiple comparisons using Bonferroni adjustment, providers who were in practice for fewer than 6 years ($p = .0036$), who did not practice in academic medical settings ($p = .002$), and who expressed strong interest in counseling patients about genetic testing related to smoking behavior, prevention, and cessation ($p \leq .0001$) were statistically significantly more willing to offer testing across scenarios. Other covariates considered, including age, gender, race, professional training and affiliation, formal genetics training, research optimism, and knowledge about counseling patients about genetic testing related to smoking behavior, prevention, and cessation,

Table I. Provider Willingness to Recommend Genetic Susceptibility Testing under Specific Conditions by Disease and Lifestyle

	Nonsmoker		Smoker	
	Agree <i>N</i> (%)	Disagree <i>N</i> (%)	Agree <i>N</i> (%)	Disagree <i>N</i> (%)
Nicotine addiction				
Unconditionally	38 (16)	194 (84)	72 (31)	158 (68)
With patient/parent assent/consent	123 (53)	108 (47)	135 (59)	94 (41)
With genetic counseling	62 (28)	168 (72)	80 (35)	150 (65)
Without insurance coverage	23 (10)	204 (90)	47 (21)	180 (79)
Preexisting chronic illness	140 (61)	89 (39)	163 (71)	66 (29)
Preexisting substance abuse history	155 (68)	74 (32)	156 (68)	73 (32)
Lung cancer				
Unconditionally	78 (34)	152 (66)	108 (48)	117 (52)
With patient/parent assent/consent	151 (65)	80 (35)	163 (72)	62 (28)
With genetic counseling	105 (46)	124 (54)	111 (49)	114 (51)
Without insurance coverage	83 (36)	146 (64)	109 (48)	117 (52)
Preexisting chronic illness	141 (62)	87 (38)	158 (70)	68 (30)
Preexisting substance abuse history	144 (63)	83 (37)	158 (70)	68 (30)

Table II. Adjusted^a ORs for Comparisons of Clinical Circumstances within Combinations of Type of GST and Patient Smoking Status

Clinical circumstances	Nicotine addiction		Lung cancer	
	Nonsmoker OR (95% CI)	Smoker OR (95% CI)	Nonsmoker OR (95% CI)	Smoker OR (95% CI)
Unconditionally	1.00	1.00	1.00	1.00
With patient/parent assent/consent	6.20 (4.12–8.30)*	3.31 (2.41–4.54)*	3.77 (2.74–5.19)*	2.94 (2.09–4.15)*
With genetic counseling	1.99 (1.28–3.10)	1.20 (0.84–1.70)	1.67 (1.17–2.37)	1.09 (0.78–1.52)
Without insurance coverage	0.57 (0.35–0.94)	0.57 (0.41–0.81)	1.09 (0.80–1.49)	1.03 (0.77–1.37)
Preexisting chronic illness	8.68 (5.85–12.88)*	5.70 (4.12–7.86)*	3.22 (2.34–4.42)*	2.59 (1.93–3.47)*
Preexisting substance abuse history	11.77 (7.77–17.81)*	4.90 (3.56–6.75)*	3.40 (2.45–4.71)*	2.65 (1.97–3.55)*

* $p < .001$.^aAdjusted for practice setting and interest in counseling patients about genetic testing related to smoking behavior, prevention, and cessation.

did not reach statistical significance and were not considered for further inclusion in multivariable models.

The number of years in practice lost its statistical significance when included in the multivariable models. Because of this, the only two covariates included in the model were practice setting ($p = .005$) and interest in counseling patients about genetic testing related to smoking behavior, prevention, and cessation ($p \leq .001$). There was no statistical significant interaction between these two covariates.

Multivariable Analyses

Multivariable analyses were performed in order to determine whether willingness to offer testing differed according to the type of test offered and the patient's smoking status (within each clinical circumstance) and also if willingness to offer testing varies across clinical circumstance (within each combination of type of test offered and the patient's smoking status). Because the unadjusted ORs and the adjusted (for practice setting and interest in counseling

patients about genetic testing related to smoking behavior, prevention, and cessation) ORs yielded identical results; only the adjusted ORs will be discussed. Because of a statistically significant three-way interaction between GST type, patient smoking behavior, and clinical circumstances ($p = .004$), we did not report the results of tests for the main effects of either one of these three variables of interest. To describe the interaction, we have evaluated the effect of each clinical circumstance within each combination of GST type and patient smoking status, and also (for completeness) the effect of each combination of GST type and patient smoking status within each clinical circumstance.

As seen in Table II, when compared to willingness to recommend testing unconditionally, the odds that providers were willing to recommend testing with the assent/consent of the patient/parent, in the presence of a preexisting chronic illness, and in the presence of a preexisting substance abuse history were significantly higher. For example, the odds that providers were willing to

recommend addiction GST to a nonsmoker with a preexisting substance abuse history was almost 12 times higher than that of unconditionally offering addiction GST to a nonsmoking patient. This same pattern was observed across all scenarios, regardless of the type of test offered and the patient's smoking status. Clinical circumstances that described the patient being seen by a genetics professional prior to testing and whether the test was covered by insurance did not reach significance.

We also assessed willingness to offer testing within each clinical scenario, as influenced by the type of GST offered and the patient's smoking status. In the context of offering testing unconditionally, compared to offering addiction GST to a nonsmoker, providers were significantly more likely to offer addiction GST to a smoker (OR = 2.36, $p < .001$) and to offer lung cancer GST, regardless of the patient was a nonsmoker (OR = 2.72, $p < .001$) or a smoker (OR = 4.99, $p < .001$). When considering the existence of a preexisting condition, either a chronic illness such as asthma or a substance abuse history, willingness was quite uniform across conditions, with the only difference being greater willingness to offer addiction GST to a smoker with a preexisting chronic illness than a nonsmoker (OR = 1.55, $p < .001$).

Discussion

The purpose of this study was to determine whether adolescent medical providers' views regarding the application of GST to their adolescent patients might be influenced by the disease in question, patient lifestyle behavior, and other clinical parameters of importance. Indeed, providers' willingness to recommend genetic susceptibility is sensitive to these factors, not only reflecting reticence toward the notion of offering GST "unconditionally," but also expressing fairly strong enthusiasm under certain circumstances.

Our hypotheses that providers would be more willing to recommend GST for an immediate health outcome, among smokers, and that certain contextual factors would play significant roles were partially confirmed. Compared to being willing to recommend GST unconditionally, providers would be more willing to recommend GST if their patient already was impacted by a chronic illness that would be affected by smoking behavior (e.g., asthma) and, in some cases, if their patient was already a smoker. These results do not support that providers would use testing as a broad primary prevention approach, but rather, that these providers envision GST as more appropriate for certain, vulnerable subgroups. Contrary to our prediction, the results further suggest that in some

contexts, providers would be more inclined towards GST for susceptibility for a distal health outcome (lung cancer) than for a more proximal one that they likely have greater familiarity with and engage on a more regular basis (nicotine addiction). It may be that providers are more comfortable in identifying risk factors for nicotine addiction and for counseling on these factors and therefore do not feel the need for additional tools. Alternatively, despite the fact that a lung cancer diagnosis might be far into the future for their patients, providers may see the threat posed by this disease as a reason to offer testing. While these responses may reflect targeted use of testing for those seen to be more "at risk," the use of GST as a primary prevention tool could provide an opportunity to reduce the overall burden of tobacco-related illness.

Our results also highlight a few areas of concern related to service delivery. Providers expressed little willingness to offer testing if it is not covered by insurance, reflecting broader concerns for the coverage of care that applies to genomic and other new technologies (Phillips et al., 2004), though we cannot know from our study whether providers' responses were governed by their preferences or by broader worksite policies that would limit their ability to offer testing if it was not covered by insurance. These coverage issues will need to be addressed as these technologies are applied more broadly if the public at large is to benefit from these advances. Willingness to offer testing was not significantly impacted by whether the patient would first be seen by genetics professional, perhaps reflecting that these services may not be feasible in many settings, given the limited number of genetic counselors and primary care providers with expertise in genetics (Greendale & Pyeritz, 2001). This underscores the importance of genetic education for healthcare professionals (Guttmacher et al., 2007).

Only practice setting and strong interest in counseling patients about genetic testing related to smoking behavior, prevention, and cessation emerged as significant covariate for these analyses. The fact that optimism for biobehavioral research in this area did not serve as a significant covariate may reflect a disconnect between optimism for future, as yet unavailable, applications and willingness to offer testing given the current state of the science. Additionally, the fact that knowledge about genetic testing related to smoking behavior, prevention, and cessation and more specifically, formal genetics training, did not serve as significant covariates in these analyses may reflect that participants expressed a low level of knowledge about this specific domain and that clinical genetics as it currently practiced does not typically integrate this type of susceptibility

testing at this time. Therefore, this formal training may be less relevant to these scenarios as this time.

Overall, our pattern of findings was similar to that found in previous studies assessing hypothetical willingness among providers to provide testing to minor patients. In a survey of European clinicians (Borry et al., 2008), less than half of providers indicated that they believed 16- and 17-year-olds were mature enough to request predictive or presymptomatic genetic tests for adult-onset disease (35%) and would offer such testing in the absence of parental consent (40%), though greater support was found with parental consent (61%). Importantly, these clinicians indicated strong support for the statement that such testing should only be available at the age that is considered adequate for starting medical surveillance (87%), reflecting previous guidelines and position papers in this area (Borry et al., 2006). This contrasts with another report indicating that 76% of providers would be at least somewhat willing to offer susceptibility testing for Huntington disease, a highly predictive test for a disease that has few management options, to a 16-year old with his/her assent (Welkenhuysen & Evers-Kiebooms, 2002).

Our overall findings also suggest that providers' willingness to offer GST is sensitive to patient behavior and other preexisting conditions and risk factors. This complements the likely future of genomic applications. Future genomic applications for common disease risk likely will be characterized by complex gene \times environment interactions (Khoury et al., 2005). Rather than seeing a "one size fits all" scenario, our results suggest that providers appreciate these interactions and how they may influence whether testing an individual would be beneficial. A future direction for research in this regard may be to examine how the factors examined in the present study impact the application of a family medical history as a preventive medicine tool (Green, 2007) and whether risk counseling would vary across these factors. Such studies may serve as a bridge to future genomic applications.

This study has several limitations. The sample was relatively small and our response rate was <60%, though this response rate is similar to other studies that have recruited at professional conferences and the demographics with regard to gender, age, and practice setting are similar to those applying for board certification in adolescent medicine in 2005, the year the study was conducted (American Board of Pediatrics, 2005). Likewise, our method limits our generalizability. As with all studies using hypothetical scenarios, there are likely differences between hypothetical interest and actual uptake of tests (Ropka et al., 2006). The responses of the participants in

our study also may not reflect those of other SAM members or other adolescent providers. Most of our respondents were either physicians or trainees and worked in academic medical settings. In addition, the significant number of trainees and the relatively short practice careers of the sample ($M = 10$ years) may have impacted both awareness of and optimism for genetic applications, as well as the patterns of our findings (Hofman et al., 1993). Also, the framing of the scenarios may have influenced our results. While the genetic variant associated with addiction susceptibility was presented as "strongly correlated with maintenance of smoking behavior," the gene associated with lung cancer risk was described as "(conferring) a very high risk of lung cancer." This subtle difference in the framing of the message may have led to greater willingness to test for lung cancer risk. Likewise, we did not counterbalance the scenarios and this might have influenced our study findings. Explanations for this finding should be pursued in future research on the effects of message framing for disease risk. Our examination of the effects of clinical circumstance stratified by GST type and smoking status, and the effects of GST type/patient smoking status stratified by clinical circumstance also present a confound. For example, our inability to find significant differences when comparing willingness to offer different types of GST across smoking status in the presence of a preexisting condition may reflect the high levels of willingness to offer testing in this context as compared to offering this testing unconditionally. Future studies would benefit from randomizing participants to scenarios that allow these issues to be examined separately without this confound. Finally, our results only relate to providers' willingness to recommend testing for smoking-related susceptibilities. Future work should examine whether findings differ when considering other behavioral domains and related diseases. Despite these limitations, these results provide further information regarding how providers may seek to implement GST.

In conclusion, existing professional guidelines suggest that adolescent medical providers should integrate and emphasize issues of disease prevention and control into their practice (AAP, 2001; USPHS, 2000). Genomics may one day be added to the tools available to clinicians to manage their patients' disease risk and inform appropriate preventive health strategies. The results of the study suggest that providers' willingness to offer GST is not only sensitive to the many issues that will guide the applications of this testing, but also suggest additional areas of research. It may be beneficial to examine these issues in the context of using a family history tool to further determine

factors that will impact the applications of genomics to adolescent care.

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Conflicts of interest: Dr. Abraham is on the Speaker's Bureau for Merck.

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