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Patient and Provider Response to a Prenatal Pre-Visit Education Chatbot

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PATIENT AND PROVIDER RESPONSE TO A PRENATAL PRE-VISIT EDUCATION
CHATBOT

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ABSTRACT

Chatbots are artificial intelligence programs designed to mirror human conversation via text or speech and have quickly been integrated in medicine, including genomics and genetic counseling. Much of the literature has primarily focused on participants' experiences and attitudes on the use of chatbots, with limited knowledge surrounding the perspectives and opinions of providers. Geisinger and Invitae co-developed a HIPAA-compliant prenatal pre-visit educational chatbot that provides routine patient education on genetic principles and genetic tests that are performed during the first and second trimester of pregnancy. Thirteen out of 310 patients who completed the chatbot were consented and interviewed to explore patients' experiences. Patients were all females, with an average of at least one live birth, and an average age of 31 years. Twelve out of 13 patients who completed the phone interview reported that they were in their first trimester of pregnancy. Qualitative analysis of transcripts revealed three main themes: (a) attitudes, (b) value of information, and (c) format. In addition, an electronic survey was developed and administered to 95 Geisinger OBGYN providers to assess their attitudes and opinions about the chatbot. Sixteen providers completed the electronic survey. The majority of patients and providers expressed favorable attitudes about the chatbot, recognizing it as an easy, quick, and user-friendly method to communicate important information about genetic testing. The accessible nature of chatbots offers a pragmatic and efficient approach for patients to receive important information about their genetic health.

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INTRODUCTION

Chatbots are artificial intelligence programs designed to simulate human conversation via text or speech. They have been rapidly introduced in healthcare to deliver therapy for patients with mental health issues, provide diagnostic decision support, and communicate important medical information (Palancia et al., 2019). Utilizing chatbots in healthcare may have the potential to provide patients with access to immediate medical information (Palancia et al., 2019). Initial data also suggests that chatbots can help with remote patient management and allow clinicians to focus on other higher-level activities (McGreevey et al., 2020). Chatbots have been slowly integrated into the field of genetic counseling, with programs facilitating components of the session, such as pedigree-drawing tools, diagnostic clinical decision support tools, and information giving (Kearny et al., 2020). In 2019, Geisinger and Invitae co-developed a HIPAA-compliant prenatal pre-visit educational chatbot named Genetic Information Assistant (GIA). GIA's platform provides routine pre-test prenatal information, such as patient education on genetic principles and genetic tests that are performed during the first and second trimester (i.e., cell-free DNA, amniocentesis), to patients prior to their appointments with their medical provider. In addition, GIA can help patients understand how the results can inform pregnancy management. Genetic counselors and physicians are currently facing a growing demand for their services and, as a result, have begun adopting chatbots to disseminate information to patients prior to pre-test consultations in order to increase efficiency.

As the population becomes more aware of the availability of genetic testing, whether through clinical testing or direct-to-consumer testing, physicians are increasingly engaged in collecting consent and ordering genetic testing for their patients. However, evidence has shown that many providers are not prepared to educate patients about genetics or order and interpret

genetic testing results (Arora et al., 2016, Baars et al., 2005, Ha et al., 2018, Hamilton et al., 2017).

Previous studies examining the effects of a pre-visit genetics educational intervention for prenatal patients found that patients who engaged with an educational computer program had a higher level of genetics knowledge after their session than their counterparts who only met with the non-genetics provider (Yee et al., 2014). This study supports that an interactive educational tool used in conjunction with provider-based genetic counseling leads to more informed patients. Other studies that explored the use of educational materials given to patients prior to an appointment with a genetic counselor, including an interactive computer aid and educational videos, did not yield increased participant knowledge retention (Green et al., 2006, Hernan et al., 2019). Such findings indicate that informative and interactive educational tools may help to increase patient comprehension, particularly when meeting with a non-genetics provider. Other studies have shown that not all educational tools are equally effective, and it stands to be seen if GIA is effective in educating patients (Hernan et al, 2019). It should be noted that across multiple studies, regardless of the efficacy of the educational aid, patients rated the educational tools highly and felt that they enhanced, or did not detract from, the patient experience (Yee et al. 2014, Green et al. 2005, Hernan et al. 2019, Chetlen et al. 2019).

While much research surrounds the attitudes of patients towards chatbots (Nadarzynski et al., 2019, Schmidlen et al., 2019), little is known about the perspectives of providers on the use of chatbots in healthcare. The use of chatbots in healthcare may pose both benefits and costs for providers. Providers recognize that chatbots can be important for patients, especially in helping patients better manage their own health and answering commonly asked questions (Palancia et al., 2019). On the other hand, providers emphasize that chatbots have the inability to understand

emotions and do not believe that chatbots are advanced enough to replace decision-making tasks that require an expert medical opinion (Palancia et al., 2019). For these reasons, chatbots are best suited to supplement and assist provider-patient interactions rather than to replace these interactions entirely. Generally, providers support the use of chatbots, would likely use them in their practice, and would recommend them to their colleagues (Palancia et al., 2019). Providers have traditionally been gatekeepers of delivering important medical information to patients. Thus, as chatbots are increasingly utilized in patient care, it is crucial to both understand the perspective of medical providers and engage them directly as stakeholders in chatbot development.

In 2020, the American College of Obstetrics and Gynecologists (ACOG) updated their guidelines stating that aneuploidy screening should be offered to all pregnant individuals regardless of age. ACOG endorsed multiple screening methods, including the traditional serum protein screen and cell-free DNA (cffDNA) tests, with cffDNA offering higher sensitivity and specificity. As an increasing number of patients are offered genetic testing, non-genetics medical providers are left to convey genetic information to their patients. This further highlights the potential for chatbots to help bridge the gap between patients and providers.

Despite the increasing incorporation of chatbots in healthcare, research is limited on the implementation of chatbots in a prenatal clinical setting. There is a limited scope of data that investigates patient and providers' concerns and attitudes towards chatbots. This study will contribute to the growing body of knowledge for utilization of chatbots in prenatal care to support providers in delivering patient education. It may also serve as a resource for genetic counselors who are interested in adopting chatbots within their institution. This study analyzed

patient response to a prenatal pre-visit education chatbot and explored providers' attitudes regarding the use of chatbots in healthcare.

METHODS

A mixed methods study was conducted to gain insight on patient and provider perception of the prenatal pre-visit education chatbot. The chatbot, co-developed by Invitae and Geisinger, was studied between May 2019 and January 2021. The study received full ethics clearance from the Geisinger Institutional Review Board and the Sarah Lawrence Institutional Review Board.

Patient Demographics

A link to the chatbot was distributed via text message or email to 371 Geisinger OB-GYN patients prior to their initial prenatal visit at the Grays Woods clinic. Geisinger is a rural health system in Pennsylvania. Patients were asked to engage with the chatbot, via email or text, prior to their scheduled appointment with their OB provider. 310 of the 371 patients completed the chatbot. 13 patients who completed the chatbot also consented to be contacted by the study team for a telephone interview to assess their experience with the chatbot.

Patient demographic information was collected utilizing three methods. The first method of demographic information collection was the information patients shared with the chatbot. This included the number of living children and current gestational age at the time of completing the chatbot. The second method utilized Geisinger's Electronic Health Record (EHR) system to obtain pertinent demographic information, including current age as well as gravida and para status. The third method collected logistical data on how the chatbot was utilized by each patient. This included the number of times the chatbot was opened, whether the chatbot was accessed from a text or email, and if the chatbot was completed.

A summary of patient demographics was analyzed in Microsoft Excel using descriptive statistics. Information compiled included mean age, mean number of living children, the trimester in which the chatbot was completed, and frequency of access of the chatbot. The data was further stratified into the following smaller groups: all patients who received the chatbot, all patients who completed the chatbot, all patients who did not complete the chatbot, and all patients who completed a phone interview. This information is presented in Table 1.

Patient Interviews

A tailored interview guide was developed to facilitate communication with patients (Appendix A). Patients were recruited by the chatbot and gave consent within the chatbot to be contacted for the interview between December 2020 and January 2021. Patients were contacted via phone and confirmed their interest in participating. Thirteen patients who were over the age of 18 confirmed interest and provided verbal informed consent. Interviews lasted between 5 and 10 minutes and were audio recorded. After the interview, we confirmed the patients' email address to distribute an electronic gift card to Amazon as an incentive to participate. The audio files were subsequently transcribed verbatim.

Each transcript was coded independently by either SG, CM, or CU. Transcripts were analyzed via qualitative thematic content analysis approach to develop a preliminary coding scheme related to the research questions. Transcripts were verified against the audio recordings and the interview guide was utilized to provide a framework in establishing the primary codes. Codes were then validated by all three researchers. Codes were modified as needed and definitions of the codes were established. After the final code book was developed, all transcripts were reviewed line-by-line to ensure coding consistency. Developing concepts were discussed

among the team throughout analysis to organize thoughts and relationships about the emerging themes.

Provider Survey

A total of 16 providers completed the survey. Participants were Geisinger OB-GYN providers, including physicians, nurse practitioners, physician assistants, and certified nurse-midwives.

A demo link of the chatbot and an online survey was distributed to 95 Geisinger OB-GYN providers through email. The inclusion criteria included any recipient of the demo link who consented via online survey to participate. No restrictions on age, gender, or previous use of chatbots were implemented. Exclusion criteria included any recipients of the demo link that did not consent via online survey to participate.

Providers were asked to take part in a research study that explores provider perception of a prenatal pre-visit education chatbot and attitudes on incorporating chatbots within prenatal practice. Providers were asked to complete an online demo of the chatbot and subsequently complete an anonymous online survey. The survey was administered by Google Forms, and the survey link was included at the end of the chatbot demo. The survey consisted of 16 Likert-scale items and 2 multiple choice questions gathering their views concerning the use of the chatbot. Response options for Likert-scale items were "strongly agree," "agree," "neutral," "disagree," and "strongly disagree." To protect the privacy of providers, no personal identifiers were collected in the survey. Participants were invited to provide their email address after completion of the survey to receive an electronic gift card to Dunkin' as an incentive to participate. Email addresses were uncoupled from survey responses. The complete survey is included in the supplementary materials (Appendix B).

Providers who selected "strongly agree" or "agree" were classified as "Agree." Those who selected "neutral" were classified as "Neutral," and those who selected "disagree" or "strongly disagree" were classified as "Disagree." Data was analyzed in Microsoft Excel using descriptive statistics to identify trends of provider responses to survey questions regarding the prenatal chatbot. The data was compiled in Table 2 to display the distribution of responses.

RESULTS

Population

TABLE 1: Total number of patients who completed or did not complete the chatbot from May 2020 to January 2021		
	N	**%**
Total patients who received the chatbot	371	100%
Completed chatbot	310	83.56%
1st attempt	289	93.23%
2nd attempt	21	6.77%
Used cell phone	301	97.10%
Used email	9	2.90%
Did not complete chatbot	61	16.44%
Never opened	51	83.61%
1st attempt	8	13.11%
2nd attempt	2	3.28%

A large proportion of patients (83.56%, 310/371) completed the chatbot. The majority of patients (93.23%, 289/301) completed the chatbot in a single attempt. Out of the 371 patients, 16.44% (61/371) of patients did not complete the chatbot, with a majority (83.61%, 51/61) of such patients never opening the chatbot. The chatbot was distributed to patients via text message or email. Most patients (97.10%, 301/310) accessed the chatbot via text. A small number of patients (2.90%, 9/301) accessed the chatbot via email.

Patient Demographics

There is no discernible difference between the patients who completed the chatbot and those who did not in terms of current age or number of living children. Among patients who

received the chatbot, the average patient age was 29.4 years old with 0.97 children in the household. For those that completed the chatbot, 280 of the 310 reported their gestational age. Approximately 90.7% (254/280) reported being in their first trimester at the time of completing the chatbot, 7.14% (20/280) were in their second trimester, and 2.14% (6/280) were in their third trimester. The average age of patients interviewed was 31.23 years with 1.154 children. Twelve out of 13 patients who completed the phone interview reported that they were in their first trimester of pregnancy.

Provider Results

A total of 75% (12/16) of providers shared that they discuss genetic testing options prior to any adverse indicators with all of their patients, 18.8% (3/16) discuss testing with most of their patients, and 6.3% (1/16) discuss testing with some of their patients (Figure 1). In addition, 37.5% (6/16) of providers said that they typically spend 0-5 minutes educating their patients on genetics, while 62.5% (10/16) of providers said that they typically spend 5-10 minutes (Figure 2). To determine if overall attitudes toward genetics may have biased attitudes towards the chatbot, the correlation between time spent discussing genetics and positive or negative views of the chatbot was examined. No such relationship was observed.

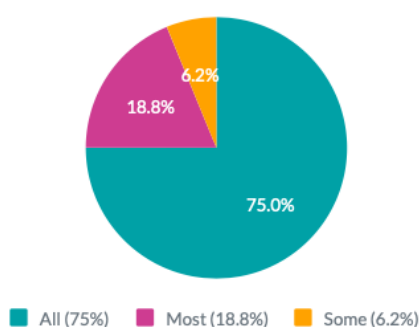Figure 1: Proportion of patients with whom providers discuss genetic testing options prior to adverse indicators

6.2%
18.8%
75.0%

■ All (75%) ■ Most (18.8%) ■ Some (6.2%)

Figure 2: Time spent by providers educating patients on genetics

37.5%
62.5%

■ 0-5 minutes (37.5%) ■ 5-10 minutes (62.5%)
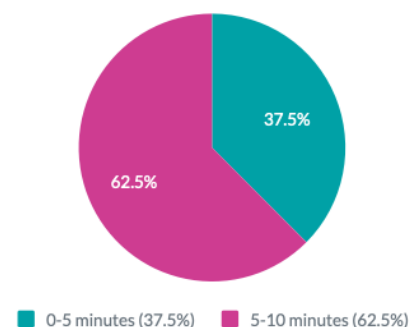
TABLE 2: PROVIDER SURVEY RESPONSES			
Question	**Strongly Agree or Agree (4 or 5)**	**Neutral (3)**	**Strongly Disagree or Disagree (1 or 2)**
I believe this chatbot is an appropriate method for communicating basic genetic information to patients.	87.5%	0.0%	12.5%
I believe this chatbot will be informative to my patients.	87.5%	12.5%	0.0%
I believe this chatbot would be confusing to my patients.	12.5%	18.8%	68.8%
I believe that the majority of my patients would be willing to engage with this chatbot.	50.0%	25.0%	25.0%
I believe that the majority of my patients will understand the genetic information provided by this chatbot.	62.5%	25.0%	12.5%
I believe that the majority of my patients would have difficulty understanding the genetic information provided by this chatbot.	18.8%	25.0%	56.3%
I believe that patients will be better prepared to make genetic testing decisions after engaging with this chatbot.	81.3%	6.3%	12.5%
I am concerned about patients' data privacy when using this chatbot.	6.3%	0.0%	93.8%
I feel comfortable educating patients about genetics.	81.3%	18.8%	0.0%
I would feel more comfortable knowing that patients received this genetics education before their appointment.	68.8%	18.8%	12.5%
I believe that incorporating this chatbot into my practice will improve patient understanding of genetics and genetic testing options.	75.0%	18.8%	6.3%
I believe that the incorporation of this chatbot will improve my overall practice.	62.5%	31.3%	6.3%
I would like to use this chatbot in my own prenatal practice.	62.5%	25.0%	12.5%

I would recommend the use of this chatbot to my colleagues.	68.8%	18.8%	12.5%
I believe this chatbot is ready to be used with all of Geisinger's prenatal patients.	62.5%	6.3%	31.3%
I believe that a chatbot like this may play a significant role in patients' healthcare, now or in the foreseeable future.	68.8%	25.0%	6.3%

Attitudes

Half of the providers surveyed (8/16) felt that a majority of their patients would be willing to engage with the chatbot. A quarter of providers (4/16) reported being neutral on the matter while the remaining quarter (4/16) disagreed. Furthermore, 12.5% (2/16) of providers mentioned they were concerned that the length of the chatbot would deter patients from completing it prior to their appointment.

> *I think my biggest concern is if patients will sit down and take the time to use it,*
> *especially before their first appointment.*

> (Geisinger provider)

> *Patients may be more receptive to online access to education materials [a website]*
> *rather than going through the chatbot as this is time consuming.*

> (Geisinger provider)

In contrast, 83.56% (310/371) of patients completed the chatbot with the majority (93.23%, 289/310) doing so in a single attempt. Among the 13 patients interviewed, a significant proportion completed the chatbot in 13 minutes or less with an average duration of 15.7 minutes. Moreover, they each expressed comfortability, convenience, and ease when using the chatbot.

I thought it was pretty cool, very technologically savvy. You got to do it really quick. I literally did it right when I woke up. I got the information and was like, "Oh, okay. I can do this really fast."

(patient)

It stated that it would take 10 or 15 minutes, but I'm not even sure it took quite that long.

(patient)

It was actually really easy. I was grocery shopping while I was doing it.

(patient)

I can do it on my phone without speaking to a person over the phone, which sometimes I think it's more private to do it that way. You're not saying things out loud.

(patient)

Overall, 62.5% (10/16) of providers agreed that implementing the chatbot would improve their practice, 31.3% (5/16) felt neutral, and 6.3% (1/16) disagreed. Furthermore, 62.5% (10/16) of providers would like to use this chatbot in their own prenatal practice and 68.8% (11/16) would recommend the use of this chatbot to their colleagues.

The majority of patients (76.9% 10/13) reported that they would be interested in completing similar chatbots before other types of healthcare appointments. Some patients (23.07% (3/13)) expressed hesitancy about completing future chatbots. Most patients (76.9% (10/13)) stated that they would recommend this chatbot to their friends who are pregnant or interested in becoming pregnant. A few patients (15.4%, 2/13) expressed that they may potentially recommend this chatbot to their friends, and 7.7% (1/13) of patients said they would not recommend this chatbot to their friends.

Value of Information

More than half of providers (62.5%, 10/16) believe that patients would be able to understand the information provided by the chatbot, 25% (4/16) were neutral, and 12.5% (2/16) disagreed with this sentiment. On the contrary, 84.6% (11/13) of patients reported that the chatbot was not confusing.

A majority of providers believe that this chatbot will be informative to their patients (87.5%, 14/16) and that incorporating this chatbot into their practice will improve patient understanding of genetics and genetic testing options (75%, 12/16). Most providers (81.3%, 13/16) stated that they feel comfortable educating patients about genetics. Nonetheless, 68.8% (11/16) of providers stated that they would feel more comfortable knowing that patients received this genetics education prior to their appointment.

I think it helps to explain the basis of genetic conditions and sets the patient up to have a more in-depth conversation with their provider.

(Geisinger provider)

About half of the patients (46.15%, 6/13) felt that the information provided was valuable. Within this group, four were first-time mothers (66.6%, 4/6) and two had children (33.3%, 2/6).

This is my first pregnancy and I am trying to gather all the information I can. I thought the chatbot was an interesting way to do this.

(patient)

It was a little bit more in-depth than what I thought it was from my previous pregnancy that was three years ago. It gave me more in-depth information. I was like, "Hm, you know what, maybe I will get this [genetic testing] done this time.

On the other hand, 61.53% (8/13) of patients did not find the information valuable. A majority (75.0%, 6/8) of these patients had children; two were first-time mothers (25.0%, 2/8).

It would be great for a first-time [parent] that would want to know everything. But since I've been through this before, it's kind of like, "Alright, let's get through this."

(patient)

Unfortunately, this is my seventh pregnancy and we've had five losses, so I'm very familiar with genetic testing. The chatbot basically asked me my age and then immediately gets into the risks of genetic abnormalities, so if this were my first pregnancy, it would have been really heavy."

(patient)

More than half of providers (81.3%, 13/16) believe that patients will be better prepared to make genetic testing decisions after engaging with the chatbot, with 6.3% (1/16) of providers feeling neutral on this matter, and 12.5% (2/16) disagreeing. Among the patients interviewed, 30.8% (4/13) indicated that they decided to pursue genetic testing prior to completing the chatbot, 30.8% (4/13) said they did not plan to pursue genetic testing, and 23.07% (3/13) stated they were unsure about genetic testing. 15.4% (2/13) of patients did not indicate their plans for genetic testing.

Format

84.6% (11/13) of patients reported that they liked the text message format of the chatbot, with 7.7% (1/13) of patients reported a neutral feeling, and 7.7% (1/13) of patients liked the format but preferred to receive this information directly from their provider.

I would have preferred to receive it from my doctor or face to face. It [chatbot] was a little bit impersonal.

(patient)

I think that given my age and that it wanted to get into heavy genetic information, I feel more comfortable talking about those issues with a provider.

(patient)

Additionally, a significant proportion of providers (87.5%, 14/16) believe that this chatbot is an appropriate method for communicating basic genetic information to patients, whereas 12.5% (2/16) disagreed with that sentiment.

DISCUSSION

The objective of this study was to explore patients' and providers' opinions and attitudes about the prenatal pre-visit education chatbot. Ultimately, both patients and providers demonstrated favorable responses.

Attitudes

Most providers who completed the survey expressed a favorable attitude towards the chatbot, would implement it in their prenatal practice, and would recommend it to their colleagues. This is consistent with previous data that measured providers' perspectives on the use of chatbots (Palancia et al., 2019). Providers felt that the chatbot would be informative to their patients and that incorporating the chatbot into their practice will improve patient understanding of genetics and genetic testing options. A minority of providers expressed concern about patient comprehension. However, most patients in this population reported that they did not find the information provided by the chatbot to be confusing. Providers reported both feeling comfortable educating patients about genetics and that they would feel more comfortable knowing that patients received this genetic education prior to their appointment. Providers reported discussing genetic testing options with a significant proportion of their patients yet only report spending a short amount of time doing so. Integration of supplementary education through a chatbot could benefit their patients' access to genetic education. Furthermore, repeated exposure to complex and potentially novel information may benefit patients and facilitate informed decision-making. This suggests that chatbots could be effectively utilized in addition to direct patient care.

Some providers voiced concerns about patient engagement. They expressed that the length of the chatbot may deter patients from completing it prior to their appointment. In

contrast, this study demonstrated a high patient response rate and the majority of patients completed the chatbot in under 13 minutes. Most patients described their experience as easy, convenient, and comfortable. This is consistent with findings from focus groups conducted by Geisinger in which patients who used GIA enjoyed being able to learn about genetic information at their own convenience (Schmidlen et al., 2019).. The vast majority of participants in this study completed the chatbot on their phones and in a single attempt. The accessible nature of chatbots offers a pragmatic and efficient approach for patients to receive important information about their genetic health.

Most patients shared that they would be willing to complete a similar chatbot before other healthcare appointments. Concerns among patients who expressed ambivalence included time constraints and preference for face-to-face communication. One patient described the chatbot as impersonal and another felt that the sensitive information would be better relayed by a provider. Despite this preference, both of these patients reported feeling comfortable engaging with the chatbot. On a similar note, most patients said that they would recommend the chatbot to their friends who are pregnant or are interested in becoming pregnant. Patients who communicated hesitancy cited reasons including unsuitability due to age of their friend groups. One common theme among both groups was the potential redundancy of information when meeting with providers.

Value of Information

The perceived value of information among patients in this population varied. Many first-time mothers found the information provided by the chatbot helpful, even expressing desire for more detailed information or additional resources. For instance, some patients stated that they would have liked to receive tips for a healthy pregnancy or links to journal articles. Those who

did not find the chatbot information valuable were patients who had prior children or reported prior knowledge of this information. One patient suggested offering an option to skip parts of the chatbot if users had familiarity with the information. Nonetheless, many of these patients recognized the utility of the information for first-time parents.

The few patients who decided to pursue genetic testing were not influenced by the chatbot. They explicitly shared that they had made their decision prior to completing the chatbot. Others who expressed that they did not want to pursue genetic testing or were unsure at the time of the interview either did not elaborate or wanted to further discuss the issue with their partner or provider. Yet it was later reported that some of the patients who initially stated they were not interested in pursuing testing did in fact pursue cell free fetal DNA (cffDNA) screening. It cannot be determined whether the subsequent interaction with their provider may have influenced their decision, or if the chatbot was a bridge in the conversation between the patient and provider.

Format

Most patients responded favorably to the text message style format of the chatbot. A majority of providers believe that a chatbot is an appropriate way to communicate basic genetic information.

Limitations

There are important limitations to note in this study. Although the chatbot completion rate was high, the number of patients interviewed was low. Complete saturation of themes may not have been reached. The sample size of providers surveyed was also relatively small. A larger sample size could increase validity and generalizability of the findings. Additionally, the high

completion rate may partially be due to the fact that many patients perceived completion of the chatbot as a mandatory part of their healthcare appointment. This may have skewed patient engagement and suggests that the way in which the chatbot is described and distributed to patients may influence participation. The completion rate may also be influenced by the transition to telehealth appointments in April 2020 in response to the COVID-19 pandemic.

Another limitation is that the technological nature of the chatbot may have caused selection bias associated with comfort using technology and socioeconomic status. Completion of the chatbot required patients to have access to smartphones and/or the internet. Furthermore, although a majority of patients did not report being confused by the chatbot, this study did not measure knowledge gained by patients after completing the chatbot. Future research should be conducted to determine the efficacy of the educational components of GIA and other developed chatbots as well as the impact on screening uptake among those who completed the chatbot.

This study is further limited by the demographics of its participants. All patients and providers were from a single health system, which serves a predominantly white and rural population. This study did not collect information regarding patient ethnicity or race. GIA was also only offered in English in this study. Additionally, the majority of patients interviewed were not first-time parents and expressed that they felt that engaging with this chatbot would be more beneficial for first-time parents.

Chatbot Development Recommendations

Patients and providers offered feedback and suggestions for how to improve the chatbot. The following suggestions may be helpful as more chatbots are being developed and integrated into the medical genetics field.

Recommendation: Inform patients that the chatbot will contain informational materials

One patient expressed not being in the right headspace to complete the chatbot, while another patient expressed that she completed the chatbot while grocery shopping. Moving forward, it may be beneficial for chatbot invitations to describe the nature of the information. This may provide patients with a better sense of time commitment and level of attention required for completing the chatbot.

Recommendation: Provide additional educational materials

A provider suggested that patients may prefer access to websites with additional educational materials. Offering educational materials, in addition to the chatbot, would give patients more opportunities to engage with the material on their own time and as much as their interest allows. Additionally, a patient suggested providing links to supporting articles regarding genetic testing options. These articles could be added to the chatbot or to the proposed online platform.

Recommendation: Provide additional pregnancy information

Patients expressed that it would be beneficial to learn more about having a healthy pregnancy, including tips for a healthy pregnancy, common pregnancy symptoms, and what foods to avoid during pregnancy. This can be integrated into the chatbot as an option to learn more or can be included in the proposed online platform.

CONCLUSION

In this population, this data suggests that pre-visit education chatbots are generally well-received by both patients and providers. Most recognize that this is an efficient, quick, and user-friendly method to communicate important information about genetic testing. Chatbots appear to be an innovative approach in delivering important medical concepts within the field of genomics and genetic counseling.

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APPENDIX A: PATIENT INTERVIEW GUIDE

Hello, may I speak with __?

Hi _____, this is (NAME) from Geisinger Research. You recently completed a pre-natal previsit education chatbot from the Geisinger OB/GYN Clinic. As part of a research protocol, we wanted to ask you some questions about your experience engaging with the chatbot. Are you available now to talk for 10 minutes, or is there a better day /time for me to call you back?

If NO- Collect better day/time to call back. Thank you, I will call you again then. Have a great day!

If Yes- Ok great! I have 16 questions to ask you about the chatbot you recently used. Our interview should take about 10 minutes. I will be recording this conversation so that we can transcribe your answers and be sure to correctly represent your thoughts. Any identifying remarks will be removed or omitted. There are no risks in participating in this project beyond those experienced in everyday life.

Do you have any questions before we begin? I'll start the recording now.

1) What motivated you to complete the chatbot?
2) How did you feel about receiving the information by the chatbot?
3) What did you find most useful about the chatbot? What did you find least useful?
4) Were there any parts of the chatbot that you felt confused by?
5) Did you feel comfortable using the chatbot?
6) What did you learn by completing this chat?
7) Did you find it easy or difficult to make time to complete the chatbot?
8) Did you like the format of the chatbot as it replicated a text message conversation?
9) What did you think of the emoticons that were used?
10) Is there anything missing from the chatbot that you think we should add?
11) Is there anything that you think we should remove from the chatbot?
12) Did you mention the use of the chatbot during your OB visit? How did the conversation about using the chatbot go?
   a. If you have not had your OB visit yet, do you have genetics questions for your OB after going through this chat?
13) After completing this chat, is there any genetic testing that you are pursuing?
14) Would you recommend this chatbot to your friends who are pregnant or interested in becoming pregnant?
15) If Geisinger sent you a similar chatbot before other types of healthcare appointments, would you be interested in completing it?
16) Is there anything that we didn't discuss today that you think is important for us to know?

Thank you for taking part in this interview! We greatly appreciate your time and participation. We will keep all your responses confidential. You should receive your $20 gift card in the next few weeks after we concluded our study at the email address you provided. If you have any

further questions, please do not hesitate to contact me at 570-214-5455. I hope you have a wonderful day and this concludes the interview.

APPENDIX B: PROVIDER SURVEY QUESTIONS

Please answer the following questions in regards to the chatbot that you just interacted with. The answers to these questions are being collected as part of a research protocol.

1. How much do you agree with the following statements: (Scale (5-Strongly Agree, 4-Agree, 3- Neutral, 2- Disagree, 1- Strongly Disagree)

"I believe this chatbot is an appropriate method for communicating basic genetic information to patients"
"I believe this chatbot would be informative to my patients"
"I believe this chatbot would be confusing to my patients"
"I believe that the majority of my patients would be willing to engage with this chatbot"
"I believe that the majority of my patients will understand the genetic information provided by this chatbot"
"I believe that the majority of my patients would have difficulty understanding the genetic information provided by this chatbot"
"I believe that patients will be better prepared to make genetic testing decisions after engaging with this chatbot"
"I am concerned about patients' data privacy when using this chatbot"
"I feel comfortable educating my patients about genetics"
"I would feel more comfortable knowing that patients received this genetics education before their appointment"
"I believe that incorporating this chatbot into my practice will improve patient understanding of genetics and genetic testing options"
"I believe that the incorporation of this chatbot will improve my overall practice"
"I would like to use this chatbot in my own prenatal practice"
"I would recommend the use of this chatbot to my colleagues"
"I believe this chatbot is ready to be used with all of Geisinger's prenatal patients"
"I believe that a chatbot like this may play a significant role in patients' healthcare, now or in the foreseeable future"

Please answer the following questions:
"How long do you typically spend educating patients on genetics?" (provide ranges 0-5 mins, 5-10 mins, etc)
"What proportion of patients do you discuss genetic testing options with prior to any adverse indicators?

Please share any additional thoughts, concerns, questions, and suggestions you may have concerning the development and implementation of GIA.