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ORIGINAL ARTICLE

Primary care physician experiences utilizing a family health history tool with electronic health record–integrated clinical decision support: an implementation process assessment

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Abstract

Family health history (FHH) screening plays a key role in disease risk identification and tailored disease prevention strategies. Primary care physicians (PCPs) are in a frontline position to provide personalized medicine recommendations identified through FHH screening; however, adoption of FHH screening tools has been slow and inconsistent in practice. Information is also lacking on PCP facilitators and barriers of utilizing family history tools with clinical decision support (CDS) embedded in the electronic health record (EHR). This study reports on PCPs' initial experiences with the Genetic and Wellness Assessment (GWA), a patient-administered FHH screening tool utilizing the EHR and CDS. Semi-structured interviews were conducted with 24 PCPs who use the GWA in a network of community-based practices. Four main themes regarding GWA implementation emerged: benefits to clinical care, challenges in practice, CDS-specific issues, and physician-recommended improvements. Sub-themes included value in improving patient access to genetic services, inadequate time to discuss GWA recommendations, lack of patient follow-through with recommendations, and alert fatigue. While PCPs valued the GWA's clinical utility, a number of challenges were identified in the administration and use of the GWA in practice. Based on participants' recommendations, iterative changes have been made to the GWA and workflow to increase efficiency, upgrade the CDS process, and provide additional education to PCPs and patients. Future studies are needed to assess a diverse sample of physicians' and patients' perspectives on the utility of FHH screening utilizing EHR-based genomics recommendations.

Keywords Clinical decision support · Family health history · Genetic screening tool · Implementation · Precision medicine · Primary care

Introduction

Family health history (FHH) plays a key role in assessing an individual's risk to develop chronic diseases. If fully incorporated into system-wide health care delivery, FHH has the potential to impact health on a population scale (Ginsburg et al. 2019). In a number of studies where FHH was systematically collected, between 41 and 82% of individuals were identified to be at increased risk of a disease and were eligible for at least one disease prevention or management strategy (O'Neil et al. 2009; Orlando et al. 2016). Additionally, a detailed family history assessment can identify entire families at increased risk for health conditions. The identification of individuals at highest risk to develop disease can lead to the use of targeted interventions for individuals and their families. Benefits of

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FHH screening include tailored disease prevention strategies such as increased disease surveillance, drug treatments, risk reducing surgeries, and lifestyle management. However, the manner in which FHH is elicited is not always systematically or consistently applied in guiding clinical care. Failure to incorporate FHH into disease risk assessment can lead to missed opportunities to intervene with preventive care.

A variety of FHH tools have been developed for use in clinical settings to identify patients who would benefit from a medical genetics evaluation and/or genetic testing services (Ozanne et al. 2009; Cohn et al. 2010; Facio et al. 2010; Hulse et al. 2011; Rubinstein et al. 2011; Baer et al. 2013; Orlando et al. 2013; Scheuner et al. 2013; Welch and Kawamoto 2013; Edelman et al. 2014; Doerr et al. 2014; Wu and Orlando 2015; Welch et al. 2018). These tools have been shown to accurately assess patients' risks for certain diseases and to increase uptake of professional guidelines (O'Neil et al. 2009; Cohn et al. 2010; Orlando et al. 2014, 2016). In spite of the utility of FHH information, the adoption of FHH screening tools has been slow in clinical practice (Wu and Orlando 2015; Allen et al. 2019). Clinical decision support (CDS) tools have been suggested as a solution to better integrate FHH and genomic medicine into clinical practice (Welch and Kawamoto 2013; Castaneda et al. 2015). CDS systems can be used to provide primary care physicians (PCPs) with information from established guidelines or best practices, and help them apply the information to a specific patient at the appropriate time during a clinical encounter (Osheroff et al. 2007). In a genomic medicine context, these tools may prove to be especially useful in overcoming some of the barriers to integrating genetics into primary care, including perceived limited knowledge and lack of comfort with this area of medicine by PCPs (Carroll et al. 2016; Hamilton et al. 2016; Owusu Obeng et al. 2018; Harding et al. 2019). Although CDS tools may help PCPs integrate genetics into their practice more effectively, few FHH tools have integrated CDS into the electronic health record (EHR) at the point of care (Baer et al. 2013; Scheuner et al. 2013; Doerr et al. 2014; Welch et al. 2018; Wu et al. 2018). By including risk algorithms and incorporating CDS into the EHR, more successful FHH integration in the clinical workflow can be achieved (Ginsburg et al. 2019).

Information is lacking about PCPs' utilization of EHR-embedded CDS as it applies to incorporating genomics in their practices, and the potential barriers and facilitators to following CDS recommendations. In a quality improvement study of *MyFamily*, a FHH and CDS tool, ten clinicians were interviewed and reported mainly system-level implementation barriers, including issues with EHR integration and clinician engagement (Doerr et al. 2014). One-on-one training was cited as a helpful facilitator (Doerr et al. 2014). Another qualitative study assessing clinicians' acceptance of CDS in precision medicine identified a number of issues including workflow challenges, cost, and need for stronger evidence of benefit from use of CDS (Chase et al. 2017). Furthermore, studies are limited in describing how PCPs incorporate EHR-based genomics CDS recommendations into their day-to-day interactions with patients, and how physicians integrate genetic testing and referral recommendations as part of a patient's annual history and exam.

The Genetic and Wellness Assessment (GWA), a patient-administered FHH screening tool utilizing CDS integrated into the EHR, was developed with the goal of providing guidance to NorthShore University HealthSystem (NorthShore) PCPs in identifying patients who have an increased probability of an inherited condition, and facilitating appropriate follow-up and care. Ultimately, through this identification process and personalized medical management, patients can be offered options to reduce disease risk and decrease morbidity and mortality.

GWA implementation

he GWA initially included 36 questions to identify NorthShore primary care patients with an increased risk for certain hereditary conditions related to cancer, cardiology, neurology, and endocrinology, based on their personal and family history of disease. The implementation of the GWA to the entire north suburban Chicago-based NorthShore primary care medical group network (27 sites) occurred from March through October 2017. The GWA was deployed via the EHR to be completed as part of the patient's annual history and exam. Both paper and electronic forms were used initially, and patients had the option to complete the questionnaire through a secure patient portal prior to their visit. Patients who did not complete the questionnaire electronically prior to their visit had the option to complete a paper version of the tool in-person at their appointment, and medical assistants entered their responses into the EHR. Functionality was later enabled which allowed patients to complete the electronic version of the questionnaire at their exam. Of the patients who completed the questionnaire, 64% completed it in the paper format. There were no differences in age ($p = 0.73$), gender ($p = 0.15$), or race ($p = 0.13$) between the patients who completed the tool online vs. the paper questionaire.

Active CDS alerts were created within the EHR to be triggered based on a patient's responses to the GWA. These alerts provided the PCP with educational information and offered the physician the choice to order a pre-selected genetic test based on the patient's indication or to refer to one of the Center for Personalized Medicine clinics. Figure 1 illustrates the GWA patient workflow. If targeted genetic testing was not indicated based on their responses to the GWA, patients could also opt for an elective panel containing 147 genes related to inherited forms of cancer, cardiovascular, and other diseases. Regardless of a patient's responses to the GWA, they could

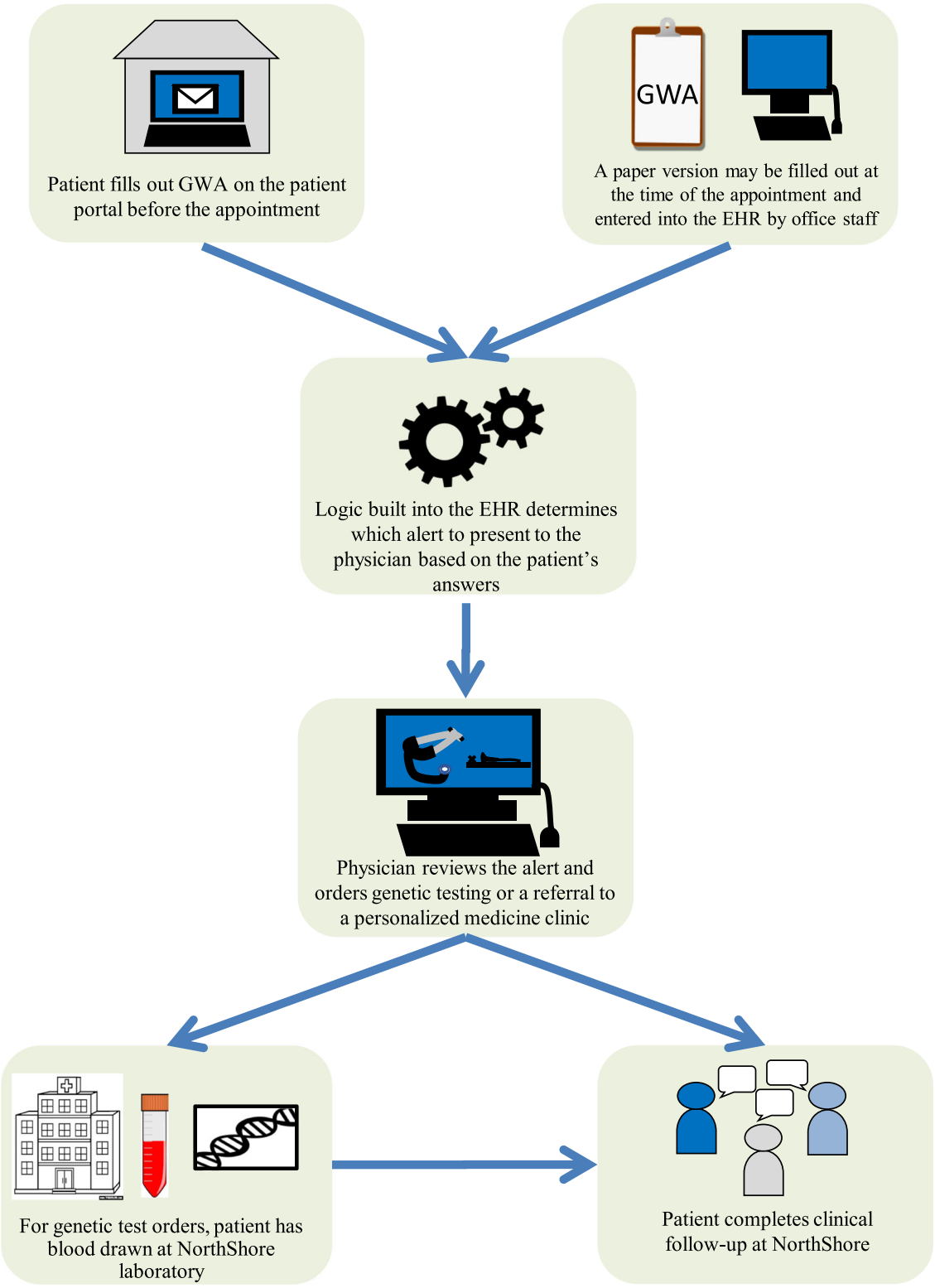

Fig. 1 GWA patient workflow

also elect to have a multi-gene pharmacogenomics (PGx) test. Both the elective panel and PGx test were offered to the patient for a fee.

Early implementation GWA utilization data from March 2017 through October 1, 2018, revealed that of 118,062 patients offered the GWA, 86,444 (73.2%) patients

were screened and 55,601 personalized medicine CDS alerts were triggered based on patient responses (Fig. 2). However, only 12,105 (21.8%) of all personalized medicine CDS recommendations were acted upon by PCPs at NorthShore practices. PCPs placed 3753 referrals to personalized medicine clinics and ordered 1590 genetic tests (including targeted multi-gene panels, PGx, and the elective 147 gene panel). The most common genetic test ordered was PGx (1023/1590, 64.3%), followed by clinically indicated breast cancer–focused multi-gene panels (256/1590, 16%). A systematic chart review was also conducted for patients who: completed a GWA-recommended clinical multi-gene panel regardless of the test result; were found to have a pathogenic variant on the elective panel; and/or who completed a personalized medicine referral through October 1, 2018. During this time frame, patients completed 250 (6.7%) referrals to specialty clinics and 226 (14.2%) genetic tests ordered by their PCP. The majority of completed patient referrals (170/250, 68%) and genetic test orders (85/226, 38%) placed by PCPs were related to hereditary breast cancer risk. These patients were either referred to a high-risk breast clinic or medical genetics for further evaluation and/or had a breast cancer–focused multi-gene panel ordered by their PCP. A separate paper is in-progress that further details the implementation process and outcomes of the GWA.

Although many patients were screened and identified to be at increased risk through the GWA, the referrals and test orders placed by PCPs represent less than a quarter of all personalized medicine CDS alerts recommended through the GWA screening. This early data demonstrated the feasibility of deploying a FHH screening tool across a primary care network; however, it was unclear what factors were influencing use of the tool in practice, and physician reactions to CDS recommendations were unknown. Therefore, an in-depth qualitative study was undertaken to explore PCPs' overall experiences with the GWA and their actions, and/or non-actions, following personalized medicine CDS notifications. This paper reports on findings of a study to assess PCPs' views of the GWA and genomics-based CDS in clinical practice.

Methods

Study participants

Study participants were NorthShore PCPs (internal medicine, family medicine, and obstetrics/gynecology) at one of the 27 primary care practice sites which had the GWA available to patients in the north suburban Chicago area. As the GWA is deployed to patients 18 and older, pediatricians were not involved in this assessment. A purposive sampling plan included identification of NorthShore physicians practicing at one of the sites offering the GWA. NorthShore PCPs were selected in order to represent a range of practice sites and primary care specialties. Participants received compensation for their time with a $150 service award. This study was reviewed and approved by NorthShore's Institutional Review Board.

Data collection

Qualitative semi-structured interviews were chosen as a method of eliciting data from participants—to allow for clarification of viewpoints, discovery of unanticipated findings, and as a strategy to learn more about the reasons underlying clinical decision-making and utilization of the GWA and CDS. Trained interviewers used a discussion guide consisting of 11 open-ended questions and probes directly relating to the study's objectives (see Supplementary Material 1). The interview guide was pretested through three cognitive interviews with PCPs practicing in the NorthShore primary care network, and revisions were made based on suggestions from these interviewees, as well as from the multi-disciplinary study team input (Willis 2005). Audiotaped individual interviews were conducted during November and December of 2018 and lasted approximately 30 min each. Interviews were analyzed on an ongoing basis until saturation of themes, or no new emerging major constructs, occurred. Saturation was reached after 24 interviews, which falls within the reported range for this type of qualitative study approach (Starks and Trinidad 2007).

Data analysis

Interview discussions were transcribed and independent checks by two investigators confirmed accurate and verbatim transcription. Transcripts were uploaded into Atlas.ti (version 7.0), a qualitative data management and analysis software program. This type of software can create a document system to store and retrieve coded text, search for words and phrases in the text, and create an index system to link categories and data (Atlas.ti 2018). The discussion guide was first used to develop a provisional list of codes. These codes were refined and changed as new ideas were encountered in the reading of each interview transcript. A final codebook of 19 codes, with definitions and quotation examples, was utilized by the investigators to identify key opinions and themes. Two investigators double coded a subset (8, 33%) of the transcripts to assess consistency in code assignments. The team worked collaboratively to reach coding agreement, and any final coding discrepancies defaulted to a senior coder. Grounded theory was used as a general guide to allow themes and theory to emerge from the transcript data (Strauss and Corbin 1998). The themes were collectively explored and

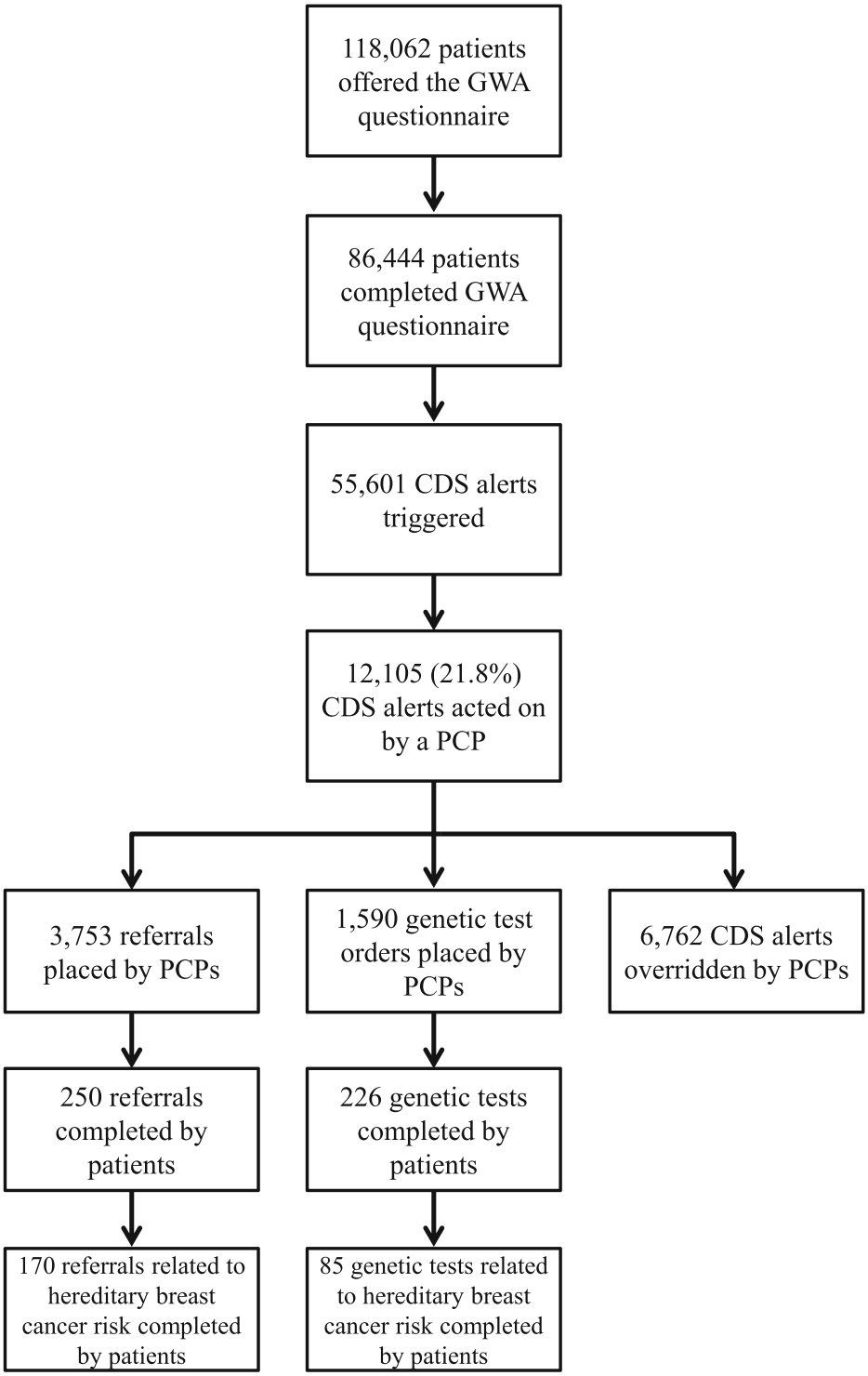

Fig. 2 GWA implementation and outcomes

interpreted by the research team. Data reduction and analysis were conducted through summative content analysis with the aim of describing the participants' views about the GWA's utility in practice (Hsieh and Shannon 2005). Key quotes were selected to illuminate the main themes of the interview findings.

Results

Participant characteristics

A total of 24 PCPs, from 14 practice sites, participated in this study. Participants' specialties included internal medicine (12,

50%), family medicine (8, 33%), and OB/GYN (4, 17%). The majority of participants (19, 79%) were female and their years in practice varied from 1 to 42 years (mean 14 years).

Main themes

Based on the investigator team review of the qualitative interview data, and input from a practicing PCP at the health system, four broad themes were identified regarding participant views toward the GWA: benefits to clinical care, challenges in practice, CDS issues, and physician recommended solutions. Each of these main themes includes sub-themes of related concepts (see Table 1). The themes and sub-themes are described, along with exemplary quotes from the PCP interview transcripts.

Theme 1: Benefits to clinical care

Participants reported a number of benefits to using the GWA in the clinical care of their patients. One positive aspect brought up was how the GWA helped increase patient awareness of the importance of their family history and facilitated patient-physician discussions about disease risk. One PCP (P10) described, *"So many families, they don't know what's happening to their brother, their sister, their aunts, their uncles, and I think this opens up a conversation for patients with their families to learn more - to improve their own health."* This physician also spoke about the manner in which the GWA helped focus patient education: *"One benefit is that it does make people think about their family and personal histories in ways that they have not thought of - where it can uncover a family history problem that can help me screen the patient and educate the patient."*

The GWA not only identifies patient disease risk, but the tool also provides CDS so that the PCP receives specific information about genetic testing and personalized medicine services available to patients within the health system. A number of clinicians highlighted that the tool provided information that they previously may not have shared with patients. This information in turn increased access to genetic services for these patients newly identified to be at risk. One participant (P22) shared: *"We don't know whether …they [patients] should necessarily proceed with getting genetic testing or seeing a genetic counselor, and this tool has helped us triage those patients a bit better because the alert does pop up. We may not be asking the right questions and the fact that there's a questionnaire there, it has picked up some patients that we may not have otherwise picked up."* In discussing views on the GWA alerts compared with other alerts, one PCP (P6) said: *"This is something new to me and not something I would do in my own work flow. A lot of the other clinical alerts that are built into Epic are stuff I do anyway. But this is one that's new and different and without the alert, I wouldn't do it [place testing orders and referrals for genetic services]."*

Another benefit described by PCPs was how the GWA CDS information helped them to guide changes in medical management of their patients. A participant (P6) described how the CDS alert and EHR process increases the ease of providing patient recommendations: *"I like that it tells you, you know this is the panel that I would recommend, and it makes it very easy that you can just click on it rather than*

Table 1 GWA implementation in primary care: major themes and sub-themes

Major themes	Sub-themes
Benefits to clinical care	- Increases patient awareness of family history - Improves patient access to genetic services - Helps guide changes in medical management - Reduces patient anxiety and uncertainty
Challenges in practice	- Lack of time - Workflow disruption - Lack of preparedness/education - Patients' poor understanding of the questions - Lack of patient follow-through
Clinical decision support issues	- Alert fatigue - CDS content differs from clinical judgment - Technical issues
Recommended improvements	- Changes to GWA and CDS structure - Changes in patient scheduling - Physician to decide when to use the GWA (other than annual exam) - Additional support staff to assist patients - More clinician education and resources

figuring out how to order it and making sure that you're doing the right one." One PCP (P9) shared how the CDS alert information helped guide them through the next steps for patient referrals, based on the risks identified through the screening tool: *"The benefit is it helps me figure out what I do next. Like, 'Okay, because you have a family history, now what do I do?' It helps me figure out, 'You'd be well-suited for doing this test' or, 'You'd be well-suited to go see the breast clinic' or et cetera."* Similarly, another participant (P4) stated: *"I think it's helpful to know that when I identify those kinds of genetics risk factors, that it's easy for me to make the referral in the system, and know who to send them [the patients] to. Because before this, I wouldn't really necessarily know for certain where to refer them."*

When asked about potential benefits of the GWA, a few participants talked about how anxiety and uncertainty were reduced in some of their patients following discussion of the tool's findings. One clinician (P8) described: *"There are certain patients, they're adopted and they're very concerned about not knowing what their family history is and what their risk is. I've done some testing on them - thankfully it's all come back negative. They've been more than happy to [do the elective testing through the GWA] just to make sure they don't have anything looming."* This same participant discussed another patient who was very concerned about getting some type of cancer, although there was no family history that the PCP was aware of. The response from the GWA screening did not identify any increased risk. Although this was just a screening result, according to the PCP, this patient apparently had some anxiety reduction about cancer following receipt of their GWA screening information.

Theme 2: Challenges in practice

While participants shared benefits of the GWA, a number of challenges were reported during early implementation: a lack of time to use the tool and CDS information in a busy clinical practice; impact on workflow; need for more education about the CDS recommendations; lack of patient understanding of the GWA questions; and patients not always following through with the recommended tests and referrals.

A key challenge noted by many participants was how adding another topic to the patient's annual visit, such as the GWA alert recommendations, was difficult because of time constraints due to discussing other recommended screens and agenda items. The GWA was provided to the patient prior to this visit and discussing the family history tool, patient findings, and genetic referrals sometimes created difficulties in time management. One clinician (P21) described their thoughts on the complexity and time needed to address GWA-related items: *"The number of questions, the time it takes. This [GWA] is something that it's on a level of its own, in terms of getting through all the questions, making sure everything is correct. Explaining to the patient what their options are because there are many. Having the testing, going to the clinic, and how it will impact their health, and their financial decision. When you get into the genetics of the patients, their genetic make-up, it gets pretty complex."* Another PCP (P24) expressed concern that due to the amount of time needed to discuss the alert recommendation, a physician might not do it. He relayed: *"Because [physicians are] rushed and they're overburdened, if they don't fully understand [the alert], and they know it's going to take a lot of time, they're going to ignore it."*

Another frustration brought up was the impact of the GWA on practice workflow. Many of the PCP participants reported having busy practices with tight schedules. Some mentioned that adding another component to the visit, such as the GWA, meant that existing processes could be taxed. While some patients had an opportunity to complete the GWA online prior to their visit, others completed the tool in the office at the time of the visit. In describing how patients were still working on the screening tool during the scheduled appointment, one PCP (P9) reported: *"It is great when the patients do the GWA before they come, like on NorthShore Connect [the patient portal], but it is hard when they do it in the office. Because often times, they spend time on their phone, they're calling their mom, they're calling their sister [to learn family history]."* Likewise, another participant (P5) described how the workflow affected both medical assistant time and physicians' opportunity to discuss the GWA CDS recommendations. They stated: *"It's added an extra step for [the medical assistants], and is difficult for the physicians in that sometimes the patients are still completing the questionnaire when we come into the room. By the time they complete it later, we have a missed opportunity for counseling and education, or even ordering the test."*

Another issue noted by participants was a need for more physician education about the GWA CDS recommendations. Some participants indicated that they did not feel fully informed, or prepared, to discuss the genetic recommendations and implications with patients. One participant (P20) shared: *"I guess I just feel like I was not well prepared to discuss this with patients. I feel like it says, 'You can order this testing,' but I don't know what that testing is. I don't know what the results look like when they come back to patients."* Another PCP (P6) reported*: "I feel like sometimes there are questions that come up about various conditions that I just don't know, because I'm not a genetics person. Also, the questions about future insurability and pre-existing conditions and the type of consequences of having genetic testing - I'm not sure I'm totally prepared to have good answers."*

Some participants also brought up the fact that a number of patients had trouble adequately answering the GWA family history questions for various reasons. A PCP (P6) noted: *"I mean the [GWA] questionnaire is confusing to patients and they don't fill it out very accurately. So I find that causes more discussion that we get into, you know it'll flag somebody because they have a family history of any blood relative with a cancer - and it was like my fourth cousin once removed…"* Another (P9) stated: *"[The issue is] people not knowing anything about their family history. Then in addition to that, people put down their husband's family history or their wife's family history because they don't understand that that is different."* One suggestion by a participant (P8) was: *"I think revisiting the way these questions are asked, and really testing it with quite a number of people that are in the mindset of being a patient would be helpful. On occasion, they've [patients] come back and asked me, 'What exactly is meant by this?' Or, 'How should I answer this?'"*

A key component of the GWA is the relaying of the CDS-recommended genetic testing and referrals to patients identified as having increased disease risk. However, participants noted that some of their patients were not following through with the recommendations after they discussed these with them. The PCPs cited various reasons for lack of follow-up on the testing and referrals such as cost, insurance concerns, fear, stigma, lack of interest, and logistical issues. For example, a participant (P4) described: *"I think they're worried about if they were to be identified to have a genetic mutation - in terms of pre-existing conditions and life insurance. These are just things that patients have mentioned to me in passing."* Denial of potential personal risk for disease due to family history was brought up by one participant as a reason for lack of patient follow-through. They (P19) stated: *"Fear. I mean, denial is a powerful thing. I've had a few patients who have just so much family history that I'm terrified for them that they're walking around with a mutation, and they're just choosing not to get testing done. I think denial and fear is a big one."* Another PCP (P14) shared their perspective on patient follow-up to the GWA recommendations: *"[Patients don't follow-up for] the same reasons why they don't follow through with the stuff I've been telling them to do for years. It's not important to them. If their elbow hurts, they're going do what I've asked them to do to make their elbow better because it's bothering them. I don't think patients like to have tests done for problems that they don't feel they have."* One clinician (P19) noted how not all patients have the same level of priority for learning genetic risk information and stated: *"And then things get put off to the side, and so I think a lot of people, they just don't get it done because it slips their mind or they don't understand the importance of it."*

Theme 3: Clinical decision support issues

A part of the interview discussion focused on CDS issues the PCPs may have encountered with the GWA. Participants discussed three main CDS issues: alert fatigue; CDS recommendations differing from their clinical judgment; and technical issues. One PCP (P7) described how they felt about the CDS (or best practice alert—BPA): *"I think the reason I don't like using the BPA tab is because it's just constantly lit. It's like there's always something in there and it's not always from the GWA. Sometimes it's Hepatitis C screening. Sometimes it's whatever, an asthma plan. There's just always something in that thing that's lit up. I have BPA fatigue or something."* Another participant (P8) shared: *"This is more of a bigger issue in general, just how many total alerts are there, and if there's too many alerts then we're just going to start ignoring all of them."* Similarly P10 reported, *"Physicians, as primary care doctors, there are so many alerts that you can become overwhelmed by alert, after alert, after alert, after alert, and dismiss it."*

Some of the participants mentioned instances when the GWA CDS information differed from what they would recommend to the patient. A PCP (P19) shared one example: *"When it [GWA] suggests referring to high risk breast [clinic] when the family history is not really suggesting higher risk, but yet the alert is firing. That's where I'm not sure what to tell them in those situations, as to whether their referral would be covered."* Another clinician (P7) discussed a particular family history where they disagreed with the CDS alert recommendation: *"If a patient answers that one family member had breast cancer and when I asked them more deeply, it's their grandma and they were 85 or something. I'm not thinking, 'Oh, I better test this patient for a breast cancer gene with just that information.' Yes, if there was more cancer in the family, then sure, but in that case, I wouldn't consider testing them."* This same participant discussed a level of threshold of concern that needs to be met before they would concur with the best practice alert: *"Just with one family member with a particular diagnosis doesn't mean that it's appropriate to be screening them. That's good information but that doesn't meet my threshold. The BPA alerts don't reach my threshold of concern."*

Several of the study participants were early implementers of the GWA; they brought up a number of technical issues they encountered related to the CDS. They described some problems with an alert firing, a duplicative recommendation in one alert, and an alert appearing after the patient chart was closed. In one instance, the clinician re-contacted the patient to remedy the situation. This PCP (P22) reported: *"There have been times where the alert doesn't fire and it's because the patient filled it [the GWA] out online and then for some reason it did not pick up a positive answer and the patient has already left the office, and I realize that it was a positive answer and she should've been given a recommendation. So then we have to call the patient back and say, 'Listen, this is a positive answer,' and kind of go through that over the phone."*

Theme 4: Primary care physician recommended improvements

Participants were asked to describe any recommended changes to the GWA or suggestions for resources that would help them to facilitate the GWA process and utilization. The main suggestions provided were: modifications to the GWA and CDS structure, changes to the GWA completion process for the patient, additional support staff, and the need for more education and resources. Table 2 details the specific recommendations offered by participants.

Discussion

Successfully incorporating FHH assessment tools into routine primary care can extend the reach of genetic services and ultimately improve health outcomes. Utilizing tools such as the GWA with associated CDS may help address the challenge of identifying patients who may benefit from further risk assessment, and bridge the PCP genetics knowledge gap by delivering pertinent guidelines and screening information at the point-of-care. Eliciting and incorporating clinician feedback on the structure and delivery of the GWA are necessary to meet patient and physician needs related to genetic medicine.

Participants in this study identified a number of benefits to using the GWA in their practice, including positive aspects for both patients and clinicians. PCPs reported increased patient awareness of their FHH and that the GWA facilitated discussions about family history and disease risk with their patients. Several benefits of GWA use for physicians were identified, including increased awareness of genetics services and the utility of CDS in guiding medical management decisions. Increased awareness and understanding of the reasons for genetic testing on the part of both physicians and patients may lead to expanded access to genetics services (Delikurt et al. 2015; Lerner et al. 2016). Some study participants also reported that they observed a reduction in patient anxiety by providing information from the GWA screening that resolved potential misunderstandings about familial genetic risk. It is possible that the GWA findings acted as an additional source of "evidence" to the patient that their FHH was not as concerning as they had imagined.

In addition to the benefits of the GWA described by participants in this study, several challenges were identified in practice. One of the main themes was a lack of time to use the GWA and CDS information during the annual visit with their patients. The competing demands on PCPs' time have been well-documented (Lizner et al. 2009; Arndt et al. 2017). Previous studies of clinician perspectives of FHH tools report varying physician opinions on

Table 2 Primary care physician–recommended improvements

Improvements recommended	Examples
Changes to GWA structure	- Make question wording more clear - Add patient introduction to GWA - Narrow scope to questions with strong evidence base
Changes to CDS structure	- Reduce verbiage in alerts - Use different font colors and highlighting to direct attention - Ability to view CDS before seeing patient - More clearly indicate why alert fired - Minimize number of alerts - Change location of alerts to family history tab in EHR - Auto-populate reason for referrals based on GWA responses
Changes in patient GWA completion process	- Patients complete GWA ahead of appointment - Complete GWA on iPad in waiting room - Establish dedicated time in appointment for patients to complete GWA in office
Additional support staff	- To help patients complete the GWA - To educate patients on GWA recommendations
More clinician education and resources	-Review topics: genetic tests; cost; insurance coverage; evidence-base in GWA questions; what history prompts a certain genetic test; which patients are at risk; patient next steps after GWA results; how patients will receive genetic results -Preferred education methods: educate prior to launching the tool; in-person training; in-office training, training at practice's monthly meetings; incentivized education; provide links to reference materials in EHR; provide case studies on actual patients who have had GWA findings -Additional resources: provide printable reference sheets and/or imbedded links in the CDS; share link to guideline testing criteria; provide sample result report; provide education sheet for patients on GWA positive screens

the time taken for use in clinic visits: some PCPs felt that it increased their time, while others felt that the various FHH tools saved them time in their patient appointments (Doerr et al. 2014; Edelman et al. 2014). Barriers to patient use of the GWA tool were also identified, and PCPs noted difficulties with patient understanding of a number of questions on the GWA questionnaire. Lack of patient follow-up with the GWA recommendations was another concern, as the potential benefits of screening may not be realized for those patients. Some of the PCPs offered reasons why patients may not follow through such as cost, insurance concerns, fear, stigma, lack of interest, and logistical issues. These barriers have also been reported by patients and physicians in studies assessing patients' reasons for declining clinical genetics services, including cancer genetic counseling and genetic testing (Geer et al. 2001; Delikurt et al. 2015; Kne et al. 2017).

Challenges related to technological aspects of the GWA CDS alerts were also identified by some of the PCPs interviewed. Participants described alert fatigue, technical issues with the EHR-imbedded CDS information, and that some CDS recommendations differed from their clinical judgment. Alert fatigue is a significant issue with CDS in general and is one of several reasons for low uptake of CDS recommendations (Cash 2009; Ancker et al. 2017). Most studies in the literature assessing CDS uptake relate to the prescription of medication, and report wide variability in alert override rates, ranging from 49 to 96% (McCoy et al. 2014; Nanji et al. 2014; Nanji et al. 2018). Alert fatigue has also been associated with burnout in PCPs (Gregory et al. 2017), which may also contribute to frustration with the CDS alerts. Additionally, several technical issues related to the integration of the alerts into the EHR were reported by participants in this study, such as alerts firing at incorrect times and duplicative recommendations.

Further education on genetics and related issues, such as insurance considerations, was a topic that came up throughout the interviews in this study. PCPs' self-reported lack of knowledge on these topics has been noted in a number of studies that examined PCPs' experiences with and preparedness to integrate genomic medicine into their practices (Carroll et al. 2016; Hamilton et al. 2016; Owusu Obeng et al. 2018; Harding et al. 2019). Given the rapid and constantly evolving nature of medical genomics, it may be challenging for PCPs to keep current in this area of practice. In some cases, PCPs reported that their clinical judgment contradicted some of the recommendations generated by the CDS alerts. This may be due to a desire to avoid overtreatment or a lack of familiarity with national guidelines for genetic testing. Adding further educational information and/or references from evidence-based recommendations to the CDS alerts may be helpful in order to clarify recommendations and educate physicians over time. This finding of discrepant views led the program to re-evaluate the disease screening questions included on the GWA in order to confirm their clinical applicability to primary care.

The challenges identified from this study have highlighted important areas to be addressed in order to improve GWA integration into primary care practice. GWA survey item validation by an independent group was undertaken and, based on recommendations, question wording changes were made to increase overall tool readability and question clarity. A short introduction was also added for each disease section in the GWA and the tool was shortened by removing family history questions about endocrinology, neurology, and some cancers. By reducing the number of questions from 36 to 24, patients take less time to complete the tool. As requested, colors were added to emphasize certain disease content. Regarding the GWA process and workflow, feedback led to enhancements such as the provision of additional support staff to assist with GWA completion and a staff command center to facilitate patient testing and referrals. Additionally, pilot testing is underway to assess the effectiveness of adding a 15-min pre-visit with the medical staff (before the annual history and exam) during which the GWA, along with other agenda items, can be discussed with the patient.

In terms of physician education, a number of efforts have been initiated based on PCP input. One-on-one training sessions have been provided at the practice sites, and a Center for Personalized Medicine Physician Advisory Group has been developed as an opportunity for PCPs to provide ongoing feedback on the GWA. Advisory group discussions have provided input on the look of the GWA-generated CDS alerts, preferences on the length of the CDS statement, and what information the CDS should contain in order to be most helpful. Single-page educational handouts have been developed for PCPs which describe the rationale and evidence for a number of the genomic CDS recommendations and next steps for patients who receive a positive GWA screen. To assist in the dissemination of information to patients, after visit summaries now outline CDS recommendations based on the GWA screening results.

Clinician feedback is essential in order to successfully incorporate FHH tools, such as the GWA, into primary care. As new health care delivery system technologies are employed, PCP input will be especially important in order to develop appropriate education, assure that practice needs are met, and document program outcomes. Responding to feedback and tailoring the GWA to the needs of PCPs may encourage its use in daily practice, thereby expanding the reach of genetics services throughout broader patient populations. Lessons learned from our engagement processes, and the deployment of the GWA, have been instrumental in the development of other population screening health initiatives at our institution (Lemke et al. 2019).

This was an exploratory study to assess PCPs' experiences with the GWA. As this was a qualitative study with a small number of participants, we did not aim for statistical significance in our findings. We were looking for new and emerging

findings that could help improve the service delivery and identification of at-risk patients through use of the GWA. However, the small sample size may not fully represent the opinions of physicians within the practice sites selected, nor the views held by PCPs practicing outside of a multi-specialty integrated health system, thereby limiting generalizability. Future quantitative studies would be helpful in evaluating whether these opinions are more universal among other PCPs who utilize the GWA. Additionally, during semi-structured interviewing, the manner in which interviewers ask questions of participants has the potential to introduce bias to responses. However, the semi-structured questions were designed to elicit open-ended responses and allow the participant to respond to the questions in a manner that has relevance to them. This allows for more varied responses and for new or additional information to emerge.

Conclusion

Physicians in this study expressed views on their experiences with the GWA. While PCPs reported benefits of the GWA, they also discussed areas of challenge encountered in practice. In addition, study participants shared recommendations to improve the workflow and identified specific educational needs. Within this health system, efforts are ongoing to address PCP concerns and needs regarding the GWA and other genomic initiatives. Collection and assessment of FHH remains an important tool to understand a patient's future risk of disease and disease outcome. Providing PCPs with a user-friendly tool to gather and act on FHH may help to expand its use in practice, and thereby impact population health. The findings from this study will be used to improve GWA utilization, and ultimately patient access to appropriate genetic testing, follow-up, and care. These findings may be helpful to other institutions developing FHH screening tools. Future studies are needed to assess a diverse sample of physicians' and patients' perspectives on the utility of FHH screening utilizing EHR-based genomics recommendations.

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Compliance with ethical standards

Conflict of interest Henry M. Dunnenberger has received consulting payments from Veritas. Amy A. Lemke, Jennifer Thompson, Peter J. Hulick, Annette W. Sereika, Christian Johnson, and Lauren Oshman declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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