Patient experiences with pharmacogenomic testing: systematic review and focus groups to inform development of a pharmacogenomic literacy assessment tool

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INTRODUCTION

- Pharmacogenomic (PGx) testing is increasingly entering mainstream clinical practice and is of great interest to patients and providers.[1] Meanwhile, patient genetic literacy is often cited as a barrier to PGx implementation.
- Research in disease risk genomics indicates that individuals with greater genomic literacy are better equipped to make informed decisions about whether to obtain genetic testing, understand the results, and take appropriate action based on the findings.[2,3]
- As a result of this disease risk research, several validated survey instruments have been developed to assess patient knowledge of key genetic concepts.[4–8] However, none of these measures tests concepts related to PGx and to date no PGx-specific validated instruments have been developed.
- In order to better understand baseline patient PGx literacy, we undertook a systematic review of published reports of participants' actual or expected subjective experience of PGx testing, and followed this with our own focus groups with individuals.

METHODS

- A systematic PubMed search was performed on Jan 6, 2020 using the discrete search string "(patient) AND (Pharmacogen*) AND (literacy OR education OR knowledge OR understanding OR perception* OR perspective* OR view* OR attitude*)". Filters on the search included English language, abstract included, published in the last 10 years.
- Eligible studies were required to include patients or general public and report on participants' actual or expected subjective experience with germline PGx testing. All direct or summarized patient feedback from each study were abstracted and underwent thematic analysis to identify common themes and subthemes.
- Participants for two focus groups were recruited from a mental health support group in southeastern MN. A third focus group was recruited from a community personalized medicine informational session at the University of Minnesota in Minneapolis, MN.
- In the first half of the focus group, participants were asked general questions about genetics, PGx, and the personal value they placed on such results. In the second half, participants were shown examples of currently available commercial PGx test reports and queried regarding their interpretation of the information presented.

RESULTS

- Results of the search string and the subsequent filtering process are described in Figure 1. Ultimately, 27 articles were included in the analysis, representing 7,530 individuals. From these 27 articles, we identified 5 themes and 17 subthemes that are described in Table 1.
- Demographic information from the three focus groups are described in Table 2. The participants in our focus groups evinced a number of the same themes identified in the literature review.
- A common source of confusion was equivocation between disease etiology/risk testing and PGx testing. Most individuals had not heard the term "pharmacogenomics" before, but were able to intuit that it related to medications and genetics.
- Expectations of what PGx testing could provide were high. When asked how much symptom improvement they would expect to receive from a PGx-guided medication with a baseline response rate of 40-50%, based on a test costing $300 out of pocket, respondents indicated they would expect the response rate to improve to roughly 75%. However, some participants stated that any amount of improvement would be worth the cost, evincing frustration with the trial-and-error prescribing process.
- When participants reviewed PGx test reports, the stoplight binning approach used by many companies caused considerable confusion. Participants' initial response to the color coding was that green indicated drugs that would be effective for them, while red indicated drugs that would be ineffective or harmful. When participants were informed that companies intended to convey a message of increasing risk of drug interaction, most participants felt this message was discordant with the message sent by the color-coding scheme.
- Participants were intrigued to find that results could be potentially useful across a number of different disease states. They unanimously felt that results ordered by one provider should be made available to all of their providers; indeed, they felt it would be negligent for a specialist (e.g. a psychiatrist) to not share the results with the participants' primary care physician, or for example, their cardiologist.
- Participants were instructed to read the limitations and disclaimers section of the report. Most participants felt less confident in the results of the testing, particularly when seeing that the tests had not been cleared by the FDA and when reading disclaimer language explaining the limitations of PCR-based testing to identify all possible genetic variants. Several participants mentioned privacy concerns and wanted to be informed about who would have access to their results. However, nearly all participants later stated that they would still want the testing done, provided they were properly informed up front.

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TABLE 1: SYSTEMATIC REVIEW THEMATIC ANALYSIS

Theme	Subtheme	Representative statements [Bracket indicates study source]
Understanding of test results	General understanding of testing	• 94% had no prior knowledge of PGx and most were unable to define the term. [U] • "What do they find out when they say 'by my blood test' and the picture of me? So what in my blood tells him that this drug is better than that drug?" [M]
	PGx testing vs disease/trait testing	• "Are they getting information about my IQ? My willingness to work Monday through Friday," or my need to call in for a vacation day…?" [I] • "It [helped] in my situation to realize that I don't have many health issues." [AA]
	Confusion about report language	• Confusion about the terms "metabolize," "enzyme", "adverse response" [T] • "Use layman's terms. The term 'intermediate' was not explained well as being 'typical' or 'normal.' I showed this to my Mayo doctor; he said ignore it." [P]
	Self-research of results	• 25-40% of patients (in 3 studies) researched or planned to research their results more [J,N,P]
Psychological response to test results	Validation of previous adverse medication experiences	• "Historically…if an individual was not responding to a treatment, then it meant that the individual was having somatic symptoms… am happy that you are bringing this up because it might avoid people being told they are having somatic symptoms." [W] • In one study, 69.6% of patients reported that they felt more validated about their previous medication experiences after learning their PGx results. [N]
	Effect of testing on tolerating/ not tolerating side effects	• Knowing a medication was selected using PGx might encourage patients to tolerate more minor side effects for greater efficacy [M] • "If you went into this with more information that you may be more predetermined to have these side effects. I think it would be even stronger notion that like if I throw up tomorrow that's probably the medicine, whether it was or not." [M]
	Feelings of relief vs. anxiety	• 33% of patients in one study reported feeling nervous or anxious [J]. • 99% of patients in a different study reported feeling positive feelings, relief, and/or a sense of being informed. [B]
Impact of testing on patient/ provider relationship	Confidence in providers	• "If I have a doctor who's using this information…they're staying on the front end of available information and advances." [M] • "My physician [told me] based on my pharmaco-blood test [that] I needed my blood pressure medication changed…I was assured that this was a good idea to participate…I think it's a real positive thing." [M]
	Overreliance on test results	• "Sounds terrible…what bothers me is that I am waiting for my specialists to treat ME, NOT my test results, treat ME, not the TEST results." [W] • "You have something static, which is your genome, and the way medications react is all different. …And because the [the genome is] static, would the doctor be more inclined to say…'I'm sorry, that's what the test says?'" [I] • In one study, 12.7% of patients reported making medication changes on their own, without the guidance of their healthcare provider. {N}
	Sharing of results with other practitioners	• "I now have information (which I shared with my physicians, primary care and other) which will be very helpful should I ever need treatment for a number of conditions and [need] to make a choice of medications to use." [AA] • "Well, my most frequent interaction is with my pharmacist. So if this is about the medications and how my body handles them, the pharmacist." [U] • "My pharmacist is the mailman…my pharmacist doesn't exist." [M] • "At present I believe that…neither my GP or my pharmacist are very open to reviewing the test results." [AA]
Reasons for testing/ perceived utility	Optimizing current medications	• "I would [have] the testing done to determine the best medication – the medication that is best for you based on your genetic makeup." [E] • "You could jump off anywhere downtown and get to a store, but you want to get off closer to the store you're going to." [I] • "After my testing and results, my medications were changed and I did notice that I no longer had my ankles swelling. Even my family doctor thought prior to testing it was something else and had me on water pills…It was not until the testing was done and the medications were changed that I noticed results." [AA] • "All drugs that were given to me, going to the hospital, having adverse effects, drug rejection…I could have had fewer adverse effects, fewer visits paid to the emergency room, and my quality of life could have been better." [W]
	Optimizing future medications	• In one study, 66.7% of patients indicated plans to avoid taking a medication in the future after learning their PGx results. [N} • "To have this testing done, it may help in the future should I become sick." [AA]
	Provided information for the self-curious	• 87.5% of participants in one study identified self-curiosity as a factor influencing their decision to undergo PGx testing. [N] • "It confirmed what I already knew but did not understand…I also was fascinated with…this new evolving discipline/science/technology that is able to determine vulnerabilities due to [genetics]." [AA] • "The more information I have, the better." [AA]
Patient perceived harm	Concerns about limitations of testing	• "How accurate is this genetic testing related to medication? Is there enough track record? Is it on target?" [M] • "The test only interrogated the common variants…, leaving concerns as to whether there were 'important things…not captured?' as one participant asked." [M] • "Satisfactory but disappointed that the medications I take are not listed in the results." [AA] • "Some participants were disappointed that PGx testing might not be able to specifically determine for which side effects they would be at risk." [E]
	Cost of test/insurance coverage	• "Who will pay for this? The government? Will it be covered? Will taxpayers agree with that?" [W] • "We have a financial concern, but, above all, we want to be healthy." [W] • "We would not accept a medication for the rich and one for the poor for the DNA test." [W}
	Data privacy/abuse of information/ inappropriate disclosure	• "It could mean that the 'perfect people' could get insured but everyone else couldn't. I would want my healthcare professionals to know [about my genetic information] but I wouldn't want it on some central database. That would be highly dangerous." [A] • "That kind of led me to believe there might be something seriously risky. I mean, out of all the things, somebody turning my information over is not the most riskiest thing I can think of in my life." [O]

DISCLOSURES

- Research is sponsored by a CPNP Foundation Defining the Future Grant and a Samuel W. Melendy/William & Mildred Peters Summer Research Scholarship.
- In the past 12 months, JDA has consulted for Inagene Diagnostics and Tempus Labs. JRB has served as a consultant for OptumRx. ALP has no relevant disclosures.

DISCUSSION AND CONCLUSION

- Systematic review results demonstrated consistent themes across a diverse range of patient populations and study methodologies, which were largely corroborated in our focus groups.
- These results demonstrate a general enthusiasm among patients and members of the general public for pharmacogenomic testing as an avenue for greater personalization of medication therapy, leading to increased efficacy and reduced side effects and ultimately leading to improved health outcomes. This enthusiasm in many cases can lead to overestimation of the benefits and underestimation of the limitations of PGx testing.
- Patients clearly communicated a desire for providers to arm them with the information necessary for them to make informed decisions about PGx testing.
- Our next steps include finalizing the qualitative analysis of the focus group results and constructing tools to assess and address patients' pharmacogenomic educational needs for the purposes of improving informed consent prior to testing, comprehension of results when they are returned, and active participation in application of PGx test results to medication selection in a shared decision making model.

FIGURE 1: SYSTEMATIC SEARCH RESULTS

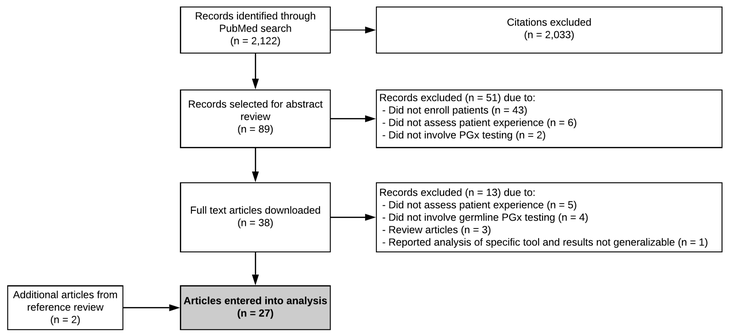

TABLE 2: FOCUS GROUP DEMOGRAPHICS

	Participants (n = 21)	
	n	%
Gender (Female)	12	57.1
Age*		
18-34	2	10
35-54	6	30
55-64	6	30
65+	6	30
Highest level of education completed		
High school diploma or less	3	14.3
Some college or 2 year degree	8	38.1
4 year degree	5	23.8
Some graduate school or Master's degree	3	14.3
Doctoral degree	2	9.5
Have you ever received genetic testing?*		
No	15	75
Yes, through a direct-to-consumer source	4	20
Yes, through a healthcare provider	1	5
Participants who had received PGx testing	4	19
Participants currently taking prescription medications	18	85.7
How much do you feel that you know about genetics as it is used in the medical setting?		
None	5	23.8
A little bit	7	33.3
Some	8	38.1
A lot	1	4.8
How much do you feel that you know about how medications work in the body?		
None	4	19
A little bit	6	28.6
Some	11	52.4
A lot	0	0

*Missing value due to incomplete demographic form