Research Article

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Pharmacogenomics

Evaluation of a pharmacogenetic educational toolkit for community pharmacists

Aim: Over the past several decades, the roles and services of community pharmacists have expanded beyond traditional medical dispensation and compounding, and include health services such as vaccinations, and clinical testing and screening. Incorporating pharmacogenetic (PGx) testing into the menu of pharmacy services is logical and feasible; however, few pharmacists have experience with PGx testing, and few educational resources about PGx are available to support the uptake of PGx testing in community pharmacies. **Methods:** We developed a toolkit of four resources to assist pharmacists to provide PGx testing. We conducted a survey of pharmacists in North Carolina to evaluate each component of the toolkit and the toolkit as a whole. **Results:** A total of 380 respondents completed the evaluation of one or more toolkit components (344 evaluated all four components and the overall toolkit). Most respondents (84%) have never ordered or used PGx test results. Though the usability of the toolkit overall was below average (65.1 on a range of 0–100), individual components were perceived as useful and more than 75% of pharmacists reported that they would use the toolkit components when offering testing, with the result summary sheet receiving the highest score (4.01 out of 5). Open-text comments highlighted the need for more patient-friendly language and formatting. **Conclusion:** The majority of pharmacist respondents scored the components of the toolkit favorably. The next steps will be to revise and assess use of the toolkit in community pharmacy settings.

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Keywords: community pharmacy • patient education • pharmacogenetic testing

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Although considered one of the most promising early clinical applications of the personalized (or precision) medicine movement, pharmacogenetic (PGx) testing has been slowly integrated into clinical practice. A number of delivery methods have been proposed including testing pre-emptively or at the point of care, and testing in a clinical practice, hospital or pharmacy. However, each delivery model and service location may involve different challenges. Provision of PGx testing in the pharmacy setting may be a logical extension given the expansion of pharmacy services [1], including other clinical testing, and the expertise of pharmacists to screen for drug interactions that may cause adverse events or poor response and skill in patient counseling [2,3]. Pharmacists have been involved in the provision of PGx testing, often leading to hospital-based clinical programs [4–6]. In addition, community pharmacists have expressed interest in PGx testing [7,8] and early reports have indicated successful use of testing in community pharmacies via an extension of medication therapy management [9,10].

Despite their interest in offering PGx testing and other precision medicine tools [7,8]

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community pharmacists' preparation and availability of resources may be limited, inhibiting the appropriate provision of PGx testing [7,11]. While recommended changes to include PGx in pharmacy school curricula as well as continuing education programs will likely increase pharmacist awareness about the appropriate use and application of testing, more point-of-care support may be needed and desirable for pharmacists as well as for physicians [12]. In particular, educational resources for pharmacists and patients will be important to promote efficient delivery and informed decision-making, appropriate interpretation of results and consultation with prescribers. Because of the novelty and lifetime implications of PGx testing, more effort may be required to educate patients and promote understanding of results than for other types of clinical tests [13]. Patient's understanding about the significance of the test outcome is critically important to deciding about treatment decisions [14].

Based on our experience from our prior studies on clinical delivery of PGx testing and pharmacist delivery of PGx testing, we applied principles of plain language [15] and design to develop a suite of four educational tools ('toolkit') to be used in the pharmacy setting (an information sheet, flipbook, summary results page and wallet card). In general, the testing process for any clinical test can be divided into two phases (pretesting and post-testing) and therefore, we aimed to develop tools that could be used for each phase of testing. The pretesting phase is intended to promote patient awareness and informed decision-making about the purpose of testing, and potential types of results and follow-up actions, and also improve patient's trust and satisfaction [16–21]. Two of the toolkit components (the information sheet and flipbook) were intended to facilitate introduction of PGx testing to patients. The post-testing phase typically includes an overview of the purpose of the test, reporting of results and follow-up recommendations. The summary results page and wallet card were developed to promote patient comprehension and sharing of test results. The latter two components were developed to simplify the information typically found in the official test report; the wallet card has been used elsewhere for PGx testing [22–24]. In this study, we sought feedback from pharmacists about the use of the components of this educational toolkit in order to determine pharmacists' perspectives of utility of the toolkit and to guide improvement of components to increase likelihood of use.

Methods

Survey development

We conducted an online survey of pharmacists licensed in the state of North Carolina to gather feedback about components of a PGx toolkit, as well as to ascertain pharmacists' educational needs, preferences and opinions regarding educational resources to facilitate the delivery PGx testing. The survey consisted of 50 questions divided into five sections, some adapted from validated usability and content analysis assessments of health materials as indicated: demographics (three questions); experience with PGx testing (one question); informational needs/educational preferences (four questions); review of each toolkit component (six Likert-scale questions [25] and two open-ended questions); and overall usability of the toolkit (system usability scale or SUS; ten questions) [26,27].

Table 1. Readability measures of each toolkit component.

Measure		Component no. 1: test information sheet	Component no. 2: flipbook	Component no. 3: result summary handout
Readability	Flesch–Kincaid grade level†	6.9	8	8.7
	Flesch reading ease score‡	69.1	58.6	51.8
	SMOG§	7.4	8	8.2
	Words per sentence	13.2	11.8	10.9
Complexity	Characters per word	5.6	4.8	5.0
	Characters	2680	2716	822
	Words	582	565	164
Length	Sentences	44	48	15
	Pages	2	13	1

†Text ranked on a US grade-school level based on the average number of syllables per word and words per sentence.
‡Calculated based on average number of syllables per word and words per sentence (0–100 scale; 0 = very difficult and 100 = very easy).
§Simplified Measure of Gobbledygook – measure of readability based upon the number of 3+ syllable words per sentence; for general consumer resources, scores should be <6.
SMOG: Simplified measure of gobbledygook.

Toolkit components

The toolkit included four components described in detail below; readability measures of each component are shown in Table 1 (component no. 4 is not included in the table as the card is intended to present the test results and has no descriptive text). All components are 'patient facing' tools that a pharmacist may present to patients to explain PGx testing or communicate PGx testing results. For these initial evaluations, each toolkit component was designed in black and white, with the exception of the wallet results card (an existing version of the card with a blue background and white text was used). The toolkit components are accessible on the Community Pharmacist Pharmacogenomics Network webpage [28].

- Component no. 1: Test Information Sheet on PGx Testing. The patient handout on PGx testing is a two-page test information sheet (TIS) entitled "Pharmacogenetic Testing: What You Need to Know" intended to provide a general overview of PGx testing. Information therein includes the purpose of PGx testing, what is involved with testing and the risks and benefits of testing. The format of the patient handout was modeled on Vaccination Information Statements [29]. Much of the text used in the handout was adapted from a brochure about PGx testing created for a previous trial [30] and assessed by a general population in the Durham area [31].

- Component no. 2: 'Flipbook' Guide to PGx Testing. Genetic counselors often employ print or digital 'flip-books' that include graphics and information to inform patients and families about a genetic test [32]. We adapted a similar educational flipbook from a version used in pharmacies participating in a previous trial [33]. The flipbook includes information about PGx testing to be shared prior to testing, as well as information that may aid in the discussion of PGx test results.

- Component no. 3: Result Summary Handout. The patient results summary handout is a one-page simplified test report including patient information and test results, an interpretation of the result, significance to treatment and suggested follow-up based on results.

- Component no. 4: Results Wallet Card. The results card is a wallet-sized card used to record the patient's test results. The card is to be prepared by the pharmacist and given to the patient so that they may have a convenient record of testing for themselves and to share with other ordering providers.

Data collection

An invitation to complete the survey was emailed to pharmacists via the North Carolina Board of Pharmacy listserv. The listserv includes all registered pharmacists in North Carolina, which may also include retired pharmacists or those not currently practicing. The survey was sent to 11,104 email addresses on 27 April 2015. There were 251 bounce-backs (includes out-of-office auto replies, bad email addresses and full mailboxes). A follow-up reminder was sent 2 weeks later. We used the online survey tool Qualtrics [34] to design and administer the survey. Consent was implied if the respondent proceeded to the survey after viewing an introductory page, which contained information about the survey, risks and benefits of completing the survey and contact information for the research staff. All survey responses were anonymous; no private health information was collected as part of the survey. To improve response rate, respondents who completed the survey were eligible to enter a drawing for a US$100 Amazon gift card. The study was approved by the institutional review board of the Duke University Health System (IRB# Pro00062612).

Data analysis

A total of 508 individuals opened the survey from the link in the recruitment email; 480 individuals clicked-through the consent statement and started the survey and 344 completed the survey in its entirety. If the respondent did not complete the evaluations for all four toolkit components and the overall usability evaluation, data from only the completed toolkit components were included in our final analysis (i.e., if a respondent completed the evaluation of component no. 1 and partially completed component no. 2, then only data from component no. 1 were analyzed). The number of completed evaluations for each of the toolkit components and the overall usability evaluation were as follows: 380 respondents completed evaluations for component no. 1, 362 for component no. 2, 354 for component no. 3, 346 for component no. 4 and 340 for SUS overall usability evaluation. The SUS questions were summed per the instrument's scoring system [26,27], with overall scores ranging from 0 to 100 providing a composite measure of the overall usability of the toolkit (higher scores indicated improved readability). Descriptive statistics were calculated for individual questions. We compared differences between ratings of toolkit components and respondent variables (pharmacy degree, practice setting, years in practice, education on PGx and experience with PGx testing) using χ^2 tests and *t*-tests. P-values of less than or equal to 0.05 were considered significant.

Qualitative data from open-ended questions prompting respondents to suggest ways of improving toolkit components were sorted and analyzed using QSR NVivo 10 software (QSR International, Melbourne, Australia). Specifically, each comment was sorted and coded into 'nodes' by a member of the research team; sorting and coding was then reviewed by a second team member for agreement. Themes were then categorized by toolkit component for reporting.

Results

Respondent characteristics

The largest proportion of respondents practice in a community pharmacy setting (49%) (Table 2) and have a PharmD degree (n = 284; 59%). Respondents included pharmacists with all levels of experience based on their years in practice. Regarding their education on PGx, 73% of respondents (n = 351) reported never taking a course primarily focused on PGx testing. No significant difference was observed by type of pharmacy degree and whether the respondent had had any training in PGx (p = 0.06). However, of those who have been practicing for 10 or more years (n = 155), 78.2% had not any training in PGx (compared with 62.3% who had been in practice for less than 9 years; p = 0.003). In the previous 12 months, 84% (n = 401) of respondents reported never offering or using the results of PGx testing. Among the 79 respondents that had ordered or

Table 2. Characteristics of pharmacist respondents (n = 480).

Characteristic	n (%)
Practice setting	
Community pharmacy	234 (49%)
Hospital	110 (23%)
Pharmaceutical industry	25 (5%)
Academia	18 (4%)
Government	17 (4%)
Long-term care	15 (3%)
Ambulatory care/clinic	12 (3%)
Other	49 (10%)
Highest degree attained	
PharmD	284 (59%)
BS pharmacy	172 (36%)
Other	24 (5%)
Years in practice	
0–4 years	78 (16%)
5–9 years	77 (16%)
10–19 years	97 (20%)
20–29 years	99 (21%)
30+ years	129 (27%)
Experience with PGx testing in past 12 months	
Have never offered/applied results	401 (84%)
Used PGx testing 1–5 times	48 (10%)
Used PGx testing 6–10 times	13 (3%)
Used PGx testing 11–15 times	5 (1%)
Used PGx testing 15+ times	13 (3%)
Training/course in PGx	
Yes	103 (21%)
No	351 (73%)
Do not recall	26 (5%)

Percentages may not total 100% due to rounding.

Table 3. Level of agreement with each statement per toolkit component.

Statement	Component no. 1 (TIS; n = 380)	Component no. 2: (flipbook; n = 362)	Component no. 3 (result summary handout; n = 354)	Component no. 4 (results wallet card; n = 346)
The information presented is comprehensive and complete	3.92 (0.78)	3.99 (0.76)	4.01 (0.82)	3.81 (0.88)
The information is relevant for the patient to make an informed decision about testing	3.96 (0.79)	3.87 (0.82)	NA	NA
The information is likely to be understandable for patients	3.75 (0.87)	3.23 (1.08)	3.90 (0.86)	3.23 (1.12)
The tone of the tool is appropriate for patients	3.95 (0.73)	3.65 (0.96)	4.02 (0.79)	3.56 (1.01)
The layout of the information is clearly presented to enable rapid identification of specific types of information	3.98 (0.85)	3.86 (0.85)	4.12 (0.75)	3.75 (0.94)
I would likely use the tool when offering pharmacogenetic testing to my customers	3.92 (0.88)	3.60 (1.02)	3.96 (76%; 0.86)	3.57 (1.11)
Overall mean score	3.92 (0.69)	3.70 (0.76)	4.01 (0.73)	3.58 (0.88)

Values are expressed as mean score (standard deviation) given for each toolkit component.
1: Strongly disagree; 5: Strongly agree.
NA: Not applicable; TIS:Test information sheet.

used PGx testing over the past year, the largest proportion (10%) have offered testing one- to five-times. In addition, of the 79 respondents that had ordered a PGx test in the past year, 54.4% have been practicing for 10 or more years (p = 0.0058) and 62% (n = 49) had some training in PGx (p = 0.006). No significant difference was observed by respondents who had ordered PGx testing in the past year by their practice setting (50.6% practiced in community pharmacy settings vs 49.4% in noncommunity pharmacy; p = 0.71).

Educational preferences for PGx

A total of 71% of respondents prefer learning about PGx testing via continuing education courses (n = 319); other preferred methods of education were online resources (n = 80; 18%) and pharmacy conferences (n = 36; 8%). We also asked about what types of information or resources they would like to have available beforehand or when discussing PGx testing or reviewing results with patients. The top three responses were linked to PGx guidelines (75%), patient-friendly resources to discuss testing (74%) and a basic genetics review course (73%). Pharmacists preferred to share printed brochures (n = 342; 76%) rather than online resources (n = 75; 17%) when discussing PGx testing with patients.

Assessment of toolkit components

Respondents were asked to review each of the four components of the toolkit and rate each with respect to content, presentation and likelihood to use in their own practice (Table 3). A summary of the ratings and feedback for each component are summarized below and in Table 4. For each toolkit component, we also asked respondents what, if any, additional content should be added and suggestions for other ways to improve the toolkit component.

Component no. 1 TIS

Respondents believed the layout of the TIS was clearly presented (3.98 or 83% agree/strongly agree) and that its information would enable patients to make an informed decision about testing (3.96 or 86% agree/strongly agree) (Table 3). Respondents were more likely to score the TIS favorably if they had less than 10 years in practice (p = 0.023); no association was observed for community pharmacy setting, education (Bachelor's or PharmD), PGx training or experience with PGx testing (Table 4).

Themes emerging for recommendations to improve the TIS included patient friendly language, formatting changes and inclusion of graphics. Illustrative comments from each of these themes are included below:

- "It is important to define 'gene' and 'genetic'. There is no point proceeding with this discussion if the patient does not understand that basic information;"

Table 4. Chi-square analysis scores for each component and system usability scale.

	Component no. 1 (TIS): scored favorably (n = 380)	p-value	Component no. 2 (flipbook): scored favorably (n = 362)	p-value	Component no. 3 (results summary handout): scored favorably (n = 354)	p-value	Component no. 4 (wallet card): scored favorably (n = 346)	p-value	Mean SUS score (n = 344)	p-value
Years in practice										
<10 years	112/131 (85.5%)	0.023*	82/126 (65.1%)	0.32	109/123 (88.6%)	0.006*	85/120 (70.8%)	0.12	67.98	0.01*
≥10 years	188/249 (75.5%)		141/236 (59.7%)		177/231 (76.6%)		141/226 (62.4%)		63.52	
Experience with PGx testing										
None	247/314 (78.7%)	0.77	182/297 (61.2%)	0.79	233/291 (80.0%)	0.46	185/284 (65.1%)	0.88	64.43	0.13
Offered at least once in past year	53/66 (80.0%)		41/65 (63.1%)		53/63 (84.1%)		41/ 62 (66.1%)		67.99	
Degree										
Bachelor's	102/126 (81.0%)	0.46	75/117 (64.1%)	0.50	84/113 (74.3%)	0.035*	72/110 (65.4%)	0.97	64.09	0.43
PharmD/Other	198/254 (78.0%)		148/245 (60.4%)		202/241 (83.8%)		154/236 (65.2%)		65.52	
Training in PGx (excluded 'cannot recall' responses)										
Some	61/83 (73.5%)	0.22	47/80 (58.9%)	0.63	61/78 (82.1%)	0.51	47/78 (60.2%)	0.34	64.64	0.66
None	218/273 (80.0%)		160/259 (61.8%)		225/276 (81.5%)		162/ 245 (66.1%)		65.56	
Practice setting										
Community pharmacy	141/178 (79.2%)	0.90	109/165 (66.1%)	0.11	133/163 (81.6%)	0.72	110/159 (69%)	0.16	65.98	0.32
Noncommunity pharmacy	159/202 (78.8%)		114/197 (57.9%)		153/191 (80.1%)		116/187 (62%)		64.29	

A favorable average score was 4 and 5 (on a scale from 1 to 5. Note: the denominator differs for each component based on the number of completed evaluations for each component (e.g., 380 respondents completed the evaluation for component no. 1 and 344 respondents completed for component no. 4).
*$p < 0.05$ (significant findings in bold).
PGx: Pharmacogenomics; SUS: System usability scale; TIS: Test Information Sheet.

- "Very sterile and clinical. Add some color to get better acceptance from the patient;"
- "Use pictures or info-graphics to make the information better understood by those of limited literacy level."

Several respondents identified additional types of information to include in this resource, including online resources (e.g., websites), information about cost of testing, a list of commonly prescribed drugs impacted by PGx variants and additional information about the risks and benefits of testing.

- "Could add common medications for which the testing is available;"
- "Hand out explains legal and negative issues but not benefits. Does not answer the question the patient will ask? Why should I do this? How will this help me?"

Component no. 2 (Flipbook)

Similar to the pretest handout, themes that emerged from comments about the flipbook included patient-friendly language, formatting suggestions and recommendations to include visual or graphic aids. Compared with the pretest handout and other components of the toolkit, patient-friendly language was a much greater concern when reviewing the Flipbook. Compared with other toolkit components, the flipbook scored the lowest on understandability, assessed by the statement, "The information is likely to be understandable for patients" (3.23 or 48%) (Table 3). No association with favorable scores was observed for community pharmacy setting, education (Bachelor's or PharmD), number of years in practice, PGx training or experience with PGx testing (Table 4).

- "Discussion on (slides) 6/7 seems too scientific for elderly population. Can you reword 'black box' warning? to something less alarming to general public;"
- "Prefer one page handout over flipbook;"
- "Possibly include information in tables and other formats aside from the bullet point format to help the information be clearer and more understandable to patients."

Respondents suggested including additional information such as recommendations on what actions to take given potential results, cost and the risks and benefits of testing, particularly regarding privacy.

- "(Include a) better explanation of what the results mean, re: a decision tree for prescribing Plavix;"
- "(The Flipbook") fail(s) to answer the basic question of 'Who pays for this procedure?';"
- "Include some statements about privacy. What will be disclosed and to whom. As well as retention of information;"

(Component no. 3) Result summary handout

Overall, there were fewer comments about the result summary handout compared with the three other toolkit components. The result summary handout also had the highest scores regarding all measures: information presented is comprehensive and complete (4.01); information is understandable (4.04), tone is appropriate for patients (3.90), the layout of the information is clearly presented (4.02) and likely use when offering PGx testing to customers (3.96) (Table 3). Respondents were more likely to score the results summary handout favorably if they had less than 10 years in practice ($p = 0.006$) or a PharmD or other graduate degree ($p = 0.035$); no association was observed for community pharmacy setting, PGx training or experience with PGx testing (Table 4).

Respondents had a number of positive responses to the result handout, saying "This format is nice in that it links the outcome to a decision point. Very easy to follow" and "This is my favorite so far. The information is direct and complete enough for patients to understand."

As with other toolkit components, formatting emerged as a theme in respondents' comments about the post-test handout.

- "Generic name should be written in ( ) to follow the format patients are accustomed to seeing;"
- "I would like to change the "impact on care" area. / Check boxes as follows: / – Continue Plavix / – Stop Plavix / – Stop Plavix and Start _____ / This will give the provider an area to be specific about the plan of action. I do not think that the patient needs to know the choices for alternative therapy. The provider should fill in his/her choice for that patient."

A greater emphasis for the importance of inclusion of follow-up or action recommendations was also encouraged.

- "Suggest adding another box that allows checking what actions if any have been taken or the patient needs to take. For example: / – Your physician has been contacted with these results / – Please contact your physician to discuss alternative medications / / The current set up does not make it clear who has the action if a change is needed;"

- "More detail on what the tests results actually mean to patient in clinical terms (is needed);"
- "In the last box, I would probably say something like "action recommended", which would be switching to an alternative medication, or discontinuing the current medication;"
- "Maybe have an "Other" section for the impact on care."

However, some respondents did not believe that an 'Impact on Care' section should be included, stating, "The 'impact on care' section is not good – patients don't need to self-discontinue medications, they need to be encouraged to talk w/ their prescriber."

Component no. 4 (Results card)

In general, the results card was rated in the lower half of all measures compared with the other toolkit components (and had the lowest score in two of the six measures) (Table 3). No association with favorable scores was observed for community pharmacy setting, education (Bachelor's or PharmD), number of years in practice, PGx training or experience with PGx testing (Table 4).

Though a description of the results card and its purpose were provided (that it was intended to serve as a record of the test results for patients and could be conveniently carried in their wallet and shared with physicians), many respondents appeared to misunderstand that this component was not intended to explain the results in detail. Many respondents did not perceive the results card to be very useful, commenting that patients would not likely understand the results without further explanation. For example, one respondent who was not satisfied with the quality of the resource, said, "If I gave this to one of my patients I would spend a lot of time explaining this in detail because it is not presented appropriately" and another said, "This is too short without a lot of prior education. Fourth graders couldn't understand it, so neither could half my patients." However, some respondents understood it to be a easily transportable and sharable account of results and believed it would be useful; for example, "(The results card) is NOT great for patients, but handy for the pharmacist & other health providers who would have the information readily available (kind of like an insurance card – patient does not know what all the stuff means or how it goes in our system but they know it is necessary & the providers can use it)."

As with all other toolkit components, respondents had a number of comments regarding the format of the results card.

- "Give this card a user friendly, more descriptive title. Your title shows you are buried in the details of the testing. This is a card that the patient will carry!;"
- "Would not use this color combo. Keep it black and white- easier to read, patients/HCPs can make copies;"
- "I might simplify the back a little, and just say something like "These pharmacogenetic test results may be very important when health care workers prescribe medications for you. Please keep this card with you and/or with your medication list, and share it with your healthcare providers."

Overall toolkit usability

The mean overall usability score for the toolkit as a whole was 65.1 (median 67.5; range 0–100). A score greater than 68 is considered to be of above average usability and scores less than 68 are of below average usability. Fewer years of experience (0–9 years) was associated with a higher SUS score (68.0) compared with 10 or more years of experience (SUS score 63.5; $p = 0.01$) (Table 4). No other associations were observed. Based on their comments, respondents appeared to be divided, some noting the usefulness of the toolkit or individual components ("Great design, and potentially useful to my patients" and "I think that this tool will be useful in practice"), whereas others perceived little value ("I would never use this kind of nonsense in retail pharmacy").

In addition, though not prompted, some respondents shared their perspectives and concerns about PGx testing in general. For example, one respondent pondered "What if my doctor doesn't care about the results we find?" It was also apparent from the comments that pharmacist knowledge or familiarity with testing influenced their comments, and suggested they were not prepared to provide PGx services ("I don't even understand this, so I wouldn't expect a patient to understand. And if presented with this, I wouldn't know what to do as a pharmacist"); however, others were more positive about delivering PGx services: "Make this standard of care in prescribing! This only makes sense. We are doing harm without this information."

Discussion

Introducing PGx testing to patients will entail the presentation of scientific concepts, risk estimates and health implications. The complexity of the information is compounded by the fact that the discussion involves scientific and medical concepts drawn from two disciplines: human genetics and pharmacology. Furthermore, given the novelty of the tests, pharma-

cist awareness and inexperience with PGx testing may limit the information presented to patients, particularly when providing testing services within a limited amount of time or with limited resources. New services offered through the community pharmacy will understandably require effort to increase patient awareness and knowledge. Therefore, in order to facilitate the delivery of PGx testing by community pharmacists, we developed a 'toolkit' to support communication and improve patient understanding about PGx testing.

In this first report of the development and assessment of a PGx toolkit, we find that pharmacists rated individual components of the toolkit favorably, but rated the usability of the entire toolkit below-average. Of the four individual components, the two rated highest were the TIS and the result summary handout. The high rating of the TIS may be attributed to pharmacists' familiarity and/or use of vaccine information statements, required to be disseminated to patients prior to vaccination [29,35]. Likewise, the lower scores on the flipbook and results wallet card could have been due to pharmacist unfamiliarity with a tool more often used in a clinical genetics setting or concerns about implementing a more interactive or time-consuming educational strategy. Although most of the respondents had limited training or experience with PGx testing, this was not associated with their ratings of the individual component scores.

In addition to developing effective patient educational resources, several barriers must be addressed to achieve successful implementation of educational resources in a community pharmacy setting [36,37]. Some of these barriers may have accounted for the lower overall usability score of the toolkit. We did not ascertain pharmacists' experience with the use of or provision of other pharmacy services that require patient education or reporting of test results. Although we provided a brief description of the goal of each toolkit component, pharmacists may have been confused about when or how to use the specific component, which may have impacted their evaluation of the patient educational tools and toolkit, particularly in those with less experience with patient education. Therefore, some pharmacist training (e.g., a short video) may be needed to show how and when each of the toolkit components are intended to be used in practice. Additional training on patient-education may also be useful as the passive approach of dissemination of written materials will not ensure patient comprehension. Patients have expressed interest in discussing their medications with pharmacists in addition to receiving written information about their medicine [38–43]. While pharmacists may have desired to use one or more components, use of the entire toolkit may have been perceived as unnecessary or unfeasible to use in a busy community pharmacy setting. A previous study of five community pharmacies demonstrated that a minimum amount of time was spent with patients discussion prior to testing (1–5 min) and when communicating results (less than 5 min) [33]. In addition, lack of space may impede use of all components of the toolkit.

Based on the ratings and comments, we suggest three areas to improve the overall usability score. Respondents indicated that more patient-friendly language was needed, that the tools could be re-formatted to be more aesthetically pleasing (e.g., use of color) and that more graphics or illustrations be included. Though the toolkit components were written at the recommended reading level [15], many health education resources intended specifically for patients are written at an advanced reading level [44–47], demonstrating the difficulty of effectively presenting complex health information including presentation of scientific concepts, risk estimates and health implications that often warrant use of medical terminology. The use of visual aids or graphics may help convey complex scientific or medical concepts and have been shown to improve patient understanding and recall of medical instructions and interventions [48–50]. Digital formats of the materials or patient website may also be developed to facilitate viewing of the information on a monitor or tablet within the pharmacy, reduce pharmacist time and enable patients to review the materials at home or share with family members [51–53].

Limitations

Some limitations of the study should be noted. The survey had a low response rate; many individuals accessed the home page or first page of the survey but did not complete it. Furthermore, survey invitations sent through email limits the insurability of the individual receiving it in their inbox rather than spam. Some of the individuals that completed the survey may represent early adopters or those with some knowledge of or interest in PGx. However, given that 84% of respondents never offered or used the results of PGX testing, the feedback of the majority of respondents may be based on limited understanding of PGx testing and patients' informational needs. The survey used was developed for this study and aside from the adapted system usability scale was not validated prior to use. Results may not be applicable to all pharmacists as those surveyed are only licensed in the state of North Carolina and the respondent population may reflect a biased sample.

Conclusion

The majority of surveyed pharmacists favorably scored individual components of a toolkit intended to facilitate pharmacist-patient communication about PGx testing

and test results. Though the toolkit components presented may aid in improving patient understanding of PGx and testing, it will still be important for pharmacists to overcome barriers associated with patient education in order to use these tools to engage in discussions about testing with their customers. However, the overall score of the toolkit suggest that pharmacists' may not perceive a need or desire to use all components. Improvement of the toolkit components should focus on use of more patient-friendly language, formatting and graphics.

Financial & competing interests disclosure

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Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

Executive summary

- This is the first report on the development and assessment of a pharmacogenetic educational toolkit intended for use in the community pharmacy setting.
- The majority of surveyed pharmacists favorably scored individual components of a toolkit intended to facilitate pharmacist–patient communication about pharmacogenetic testing and test results.
- However, pharmacists rated the usability of the entire toolkit below-average, possibly due to beliefs that use of the entire toolkit was unnecessary or unfeasible for a busy community pharmacy setting.
- Improvement of the toolkit components should focus on use of more patient-friendly language, formatting and graphics.

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