# Designing a theory and evidence informed pharmacogenomic testing service in community pharmacy in England


## Abstract

**Introduction:** Pharmacogenomics (PGx) uses DNA to predict an individual's response to a medicine. Internationally, the delivery of PGx is frequently via community pharmacies, who can take a saliva sample, send it off for analysis and contribute to the final clinical decision making. No similar service has been set up in England.

**Aim:** To identify the barriers, enablers and Behaviour Change Techniques (BCTs) to inform a service specification for delivery of a community pharmacy based PGx service in England.

**Method:** This qualitative co-design research study was designed in three stages using action-orientated theory-based frameworks and tools. The first stage mapped perceptions, barriers to, and enablers for, implementing a community pharmacy based PGx service, derived from a previous qualitative study onto the Theoretical Domains Framework (TDF). The second stage utilised the Theory and Techniques Tool (TTT) to link the identified TDF domain with corresponding BCTs. The final stage used a Delphi survey followed by a Nominal Group Technique session to facilitate community pharmacists selecting their preferred BCTs to include in a service specification.

**Results**: The existing qualitative data were mapped onto six TDF domains: Knowledge, Skills, Social/ professional role and identity, Optimism, Beliefs about Consequences, and Environmental context and resources. Forty-six BCTs were identified using the TTT and the consensus methods resulted in nine selected BCTs: Review outcome goal(s), Feedback on behaviour, Instruction on how to perform behaviour, Demonstration of the behaviour, Credible source and Adding objects to the environment.

**Conclusion:** Using a range of action-orientated theoretical frameworks and tools, pragmatic BCTs have been identified as part of a co-design process, which can now be used as the basis to develop a service specification for the implementation of a PGx testing service in a community pharmacy setting in England.



**Key Words:** Theoretical domains framework · theory and techniques tool · behaviour change techniques · nominal group technique · delphi technique · pharmacogenomics · community pharmacy

## Introduction

Pharmacogenomics (PGx) predicts an individual's response to drugs using DNA testing. PGx is the study of responses of patients to medication based on their genomic profile, and "*enables the evaluation of some specific genetic variants responsible for an individual's particular drug response"* (1). Furthermore, it is a specialism of personalised medicine that uses genomic information from an individual's DNA to predict their response to drugs (2). Supporting the delivery of personalised medicine, PGx can be used to reduce the likelihood of adverse drug events and increase the likelihood of the best therapy and dose being selected first time and move medicine and pharmacy away from a traditional "one size-fits-all" approach to one in which medicines and doses are tailored to the individual.

Some patients may require a higher dose, some a lower dose and others a different medication altogether. Healthcare professionals in Norway can already test patients for 150 drugs using PGx testing in routine care (3). In a recent research study in England, it was estimated that there may be an actionable drug-gene interaction (DGI) for one fifth of prescriptions for newly prescribed medicines, requiring a change of medication or dose, and this could affect one in ten of all patients taking a new medication (4). In the future PGx could be a cost effective alternative to the current "one size fits all" approach; it has been introduced and researched into community pharmacy as a pharmacist-led service in the Netherlands (5), Canada (6) (7) (8) and USA (9) (10) (11) (12) (13) (14), but not yet in England. In a recent scoping study of how PGx services across the world can inform the design and implementation in England, it was identified that "*for such services to work well they need patient interest, pharmacist engagement, training and supporting information for pharmacists and prescriber acceptance of recommendations for any changes to patients' prescriptions*" (15). Hindi, Schafheutle and Jacobs (16) identified that the convenience and access of community pharmacies was superior compared with GP clinics for pharmacy services including "m*anagement of minor ailments, medication reviews and routine check-ups for well managed long-term conditions*". In fact, community pharmacists are the final healthcare professional that a patient sees before starting new medicines making them ideally located to provide a PGx testing service.

Designing a PGx service for community pharmacy is a complex intervention. The UK Medical Research Council (MRC) recommend the use of theory to inform complex intervention design (17). Relevant frameworks and tools have been developed by behavioural scientists and implementation researchers. The Theoretical Domains Framework (TDF) is used to identify the

barriers and enablers associated with intervention implementation, whilst the Behaviour Change Technique Taxonomy v1 (BCTTv1) provides an evidence-based approach to identifying interventions to address the barriers and enablers. The TDF is a comprehensive framework which is a synthesis of theories and theoretical constructs. It was created by behavioural scientists and implementation researchers using a consensus process (18) and was later further revised and validated (19). This revised framework known as TDF(v2) consists of 14 domains of behaviour that broadly includes the key mechanisms of action (MoA) that influences healthcare professionals' behaviours, e.g., Knowledge, Skills, Social influences and Goals. The BCTs are the active ingredients of an intervention and "*the processes through which behaviour change occurs*", and influencing the behaviour are the "mechanisms of action" (20).

The TDF has been linked to the Theory and Techniques Tool (TTT), which links the identified theoeretical domains with the appropriate BCTs from the taxonmy of behaviour change (21). Determining the relevant domains enables identification of the relevant BCTs which have evidence for changing behaviour within those domains. There is a need for the target audience of community pharmacists to then select from the range of BCTs. Additionally, consensus methods can be used to select the most appropriate BCT for implementation (22).

The use of multiple action-orientated and theory-based research frameworks and tools can be deployed pragmatically to ensure the most appropriate behaviours can be identified to inform the design of a service specification for a complex intervention in this novel area of medicine in a community pharmacy setting in England.

### Aim of research

To identify the barriers, enablers and BCTs to inform the delivery of a service specification for delivery of a community pharmacy based PGx service in England.

## Methods

### Ethics Approval

This study protocol gained approval from The Research Ethics Approval Committee for Health (EP 19/20 069) at the University of Bath.

### Study Context and Design

The study was designed in three stages using action-orientated research frameworks and tools. The first stage involved mapping themes reported in a previous qualitative study by the authors. Two of the themes were enablers: In-principle receptiveness and Appreciation of the benefits.

The other three themes were barriers: Lack of implementation resources, Ambiguity about implications for implementation and Interprofessional relationship challenges. The Ambiguity about implications for implementation theme was further divided into three sub-themes: Lack of guidance to design the service, Lack of knowledge for service delivery and Lack of knowledge for clinical decision making (23). These themes were mapped onto the Theoretical Domains Framework (TDF) to identify the Mechanisms of Action (MoAs). The second stage involved using the Theory and Techniques Tool (TTT) to link the MoA of the behaviour with the Behaviour Change Technique (BCT). The final stage involved using a Delphi survey followed by a Nominal Group Technique session to enable community pharmacists to select their preferred BCTs to incorporate in a service specification for a pharmacogenomic (PGx) testing service in a community pharmacy setting in England. The method for each stage will be described separately.

**Stage 1: Map perceptions, barriers and enablers from a previous qualitative study onto the Theoretical Domains Framework.**

As part of a recent study in England, a focus group was held with community pharmacists (n=10) to establish their first thoughts on PGx, the benefits, concerns and challenges, and any resources that would be required to set up this service in a community pharmacy setting in England (23). Using the six phase reflexive thematic analysis approach (24) (25), barriers to and enablers for implementation of a PGx testing service in a community pharmacy setting were inductively generated (23). The data from the focus group was mapped onto the 14 domains of behaviour of the TDF(v2). The mapping was completed using the inductive codes and themes generated from the thematic analysis by one researcher (TR).

**Stage 2: To identify Behaviour Change Techniques using the theory and techniques tool.**

The identified MoA from the TDF(v2) were mapped onto the TTT to identify potential BCTs (21). BCTs with a link to the TDF domain and those that were inconclusive or had a marginal link were highlighted.

**Stage 3: To select Behaviour Change Techniques using consensus methods for the service intervention.**

For this stage, pharmacist participants were purposively sampled as experts in the implementation and delivery of a range of community pharmacy services and representing a diverse range of gender, experience, roles, geography, setting and size of business. Expressions of interest were sought through personal invitation and consent to participate in the study was given. For each identified barrier to and enabler for implementation, one or two BCTs were

identified to support prioritisation of BCTs for inclusion in a service specification. Each BCT was rated using evaluation criteria with the acronym APEASE (Acceptability, Practicability, Effectiveness, Affordability, Side-effects, and Equity) and selected through a robust voting process, consensus for each BCT only being achieved when 80% participants agreed to all six APEASE criteria.

Following the identification of the BCTs, a sifting process was completed by two of the authors (TR and SS) to eliminate duplicate BCTs and those that were inappropriate for the intervention in a community pharmacy setting. The sifting process also reduced the burden on participants in the consensus process to ensure quality consideration for the remaining BCTs (26). An online survey was developed using the Momentive Inc® platform (27) and piloted to ensure clarity of understanding. Deploying the Delphi Technique, the survey was presented to the pharmacist participants (n=11) over two rounds of voting using modified APEASE criteria for maximum understanding. Examples of each BCT were given to contextualise the behavioural theory language into everyday community pharmacy parlance for the participants. Following the first round of voting all results were presented back to participants with a second round of voting on those where there was no consensus in the first round.

Following two rounds of individual voting, an online consensus group was convened using the Microsoft® Teams platform to comply with Covid-19 social distancing restrictions (28). A modified Nominal Group Technique was utilised with the consensus group reviewing their first two rounds of online voting, discussing those where consensus still had not been achieved and participating in a round of ranking to finalise prioritisation of the most appropriate BCT for each domain of behaviour.

An overall summary of the study design is illustrated in Figure 1.

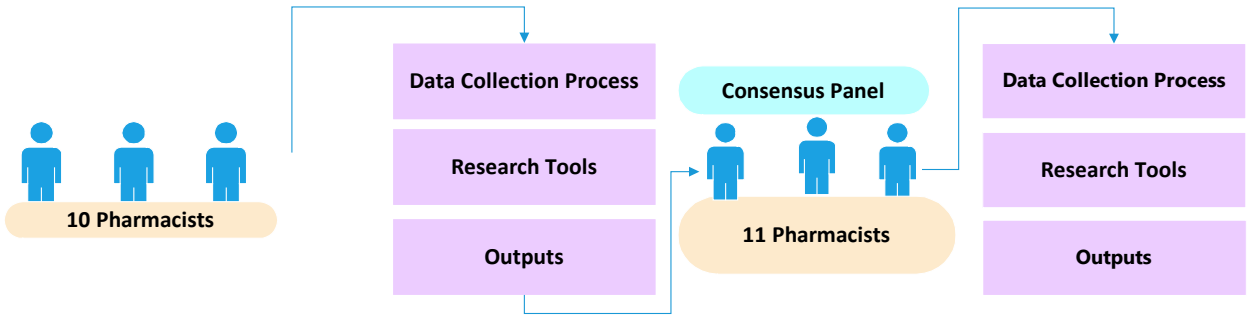



**Figure 1: : Conceptual diagram of study design**

**Data Analysis**

The online surveys were analysed to identify percentage agreement for each BCT on each of the APEASE criteria. The bar for consensus for both rounds of voting was set at a relatively high level, requiring all six APEASE criteria to have agreement from 80% participants. Partial consensus required four or five of the APEASE criteria to have agreement from 80% participants and any BCT with any lower consensus ratings were rejected. The discussion of the online consensus group was transcribed by an external company, Transcript Divas Limited® (29) into an anonymised orthographic transcript. It was then imported into the data storage and analysis software Taguette® (30) and subsequently analysed to identify key activities for inclusion in the service specification. The identified activities highlighted examples for the operationalization of each BCT.

## Results

Eleven community pharmacists participated in the consensus groups (Table 1). Three of the pharmacists from an earlier focus group were included to maintain continuity in the co-design approach being deployed in the overall study (Ph 1, Ph2 and Ph3).

**Table 1: Characteristics of participants in consensus group**

| | Gender | Position | Setting | Years in practice | Region of England | No of medicines dispensed/month |
|---|---|---|---|---|---|---|
| **Ph 1** | M | Pharmacist Manager | Standalone Pharmacy | 11 - 20 | London | 10,000 - 15,000 |
| **Ph 2** | M | Pharmacist Manager | Standalone Pharmacy | 21 - 30 | South West | 5,000 - 10,000 |
| **Ph 3** | F | Pharmacist Manager | Collocated with GP clinic | 0 - 10 | London | 5,000 - 10,000 |
| **Ph 4** | F | Pharmacy Superintendent | n/a | 21 - 30 | National | n/a |
| **Ph 5** | F | Teacher Practitioner | Collocated with GP clinic | 0 - 10 | East of England | 5,000 - 10,000 |
| **Ph 6** | F | Pharmacy Manager | Collocated with GP clinic | 0 - 10 | South West | 15,000 - 20,000 |
| **Ph 7** | F | Pharmacy Manager | Standalone Pharmacy | 31 - 40 | South West | 5,000 - 10,000 |
| **Ph 8** | M | Prescribing Pharmacist | Standalone Pharmacy | 0 - 10 | London | 5,000 - 10,000 |
| **Ph 9** | F | Regional Pharmacy Manager | Standalone Pharmacy | 11 - 20 | South West | 10,000 - 15,000 |
| **Ph 10** | M | Regional Pharmacy Manager | Collocated with GP clinic | 11 - 20 | North East | 15,000 - 20,000 |
| **Ph 11** | M | Pharmacist Manager | Collocated with GP clinic | 0 - 10 | South East | 10,000 - 15,000 |

**Stage 1: Map perceptions, barriers and enablers from a previous qualitative study onto the Theoretical Domains Framework**

The insights about the enablers and barriers from the pharmacist focus group were mapped onto six of the Theoretical Domains Framework (TDF) domains (31) as summarised in Table 2. The enabler "in- principle receptiveness" was mapped to the **Optimism** domain and "appreciation of the benefits" was mapped to the **Belief about consequences** domain. The two barriers, "lack of resources for implementation" and "lack of guidance to design the service" were mapped to the **Environmental context and resources** domain. The "lack of knowledge for service delivery" barrier was mapped to the **Skills** domain, the "lack of knowledge for clinical decision making" barrier to the **Knowledge** domain and finally the "interprofessional relationship challenges" barrier to the **Social/professional role and identity** domain.

**Table 2: Mapping data onto Theoretical Domains Framework**

| TDF Domain | Enablers | Barriers |
|---|---|---|
| **1. Knowledge** | | |
| **2. Skills** | | |
| **3. Social/professional role and identity** | | |
| **4. Beliefs about capabilities** | | |
| **5. Optimism** | | |
| **6. Beliefs about Consequences** | | |
| **7. Reinforcement** | | |
| **8. Intentions** | | |
| **9. Goals** | | |
| **10. Memory, attention & decision processes** | | |
| **11. Environmental context and resources** | | |
| **12. Social influences** | | |
| **13. Emotion** | | |
| **14. Behavioural regulation** | | |

**Stage 2: To identify Behaviour Change Techniques using the Theory and Techniques Tool.**

As a result of mapping the associated domains of behaviour from the TDF onto the Theory and Techniques Tool (TTT), 25 linked Behaviour Change Techniques (BCTs) were identified in addition to 12 BCTs with inconclusive or marginal links (Table 3).

**Table 3: Theory and Techniques Tool (21)**

| Behaviour Change Techniques | TDF Domains | | | | | |
|---|---|---|---|---|---|---|
| | Knowledge | Skills | Social/prof role and identity | Optimism | Beliefs about Conse quences | Environ mental context and resources |
| 1.2. Problem solving | | | | | | |
| 1.7. Review outcome goal(s) | | | | | | |
| 2.2 Feedback on behaviour | | | | | | |
| 2.6. Biofeedback | | | | | | |
| 3.1. Social support (unspecified) | | | | | | |
| 3.2. Social support (practical) | | | | | | |
| 4.1. Instruction on how to perform the behaviour | | | | | | |
| 4.2. Information about Antecedents | | | | | | |
| 5.1. Information about health consequences | | | | | | |
| 5.2. Salience of consequences | | | | | | |
| 5.3. Information about social and environmental consequences | | | | | | |
| 5.5. Anticipated regret | | | | | | |
| 5.6. Information about emotional consequences | | | | | | |
| 6.1. Demonstration of the behaviour | | | | | | |
| 6.2. Social comparison | | | | | | |
| 7.1. Prompts/cues | | | | | | |
| 7.2. Cue signalling reward | | | | | | |
| 8.1. Behavioural practice/rehearsal | | | | | | |
| 8.6. Generalisation of target behaviour | | | | | | |
| 8.7. Graded tasks | | | | | | |
| 9.1. Credible source | | | | | | |
| 9.2. Pros and cons | | | | | | |
| 9.3. Comparative imagining of future outcomes | | | | | | |
| 10.1. Material incentive (behaviour) | | | | | | |
| 10.8. Incentive (outcome) | | | | | | |
| 10.9. Self-reward | | | | | | |
| 10.10. Reward (outcome) | | | | | | |
| 11.3. Conserving mental resources | | | | | | |
| 12.1. Restructuring the physical environment | | | | | | |
| 12.2. Restructuring the social environment | | | | | | |
| 12.3. Avoidance/reducing exposure to cues for the behaviour | | | | | | |
| 12.5. Adding objects to the environment | | | | | | |
| 13.5. Identity associated with changed behaviour | | | | | | |

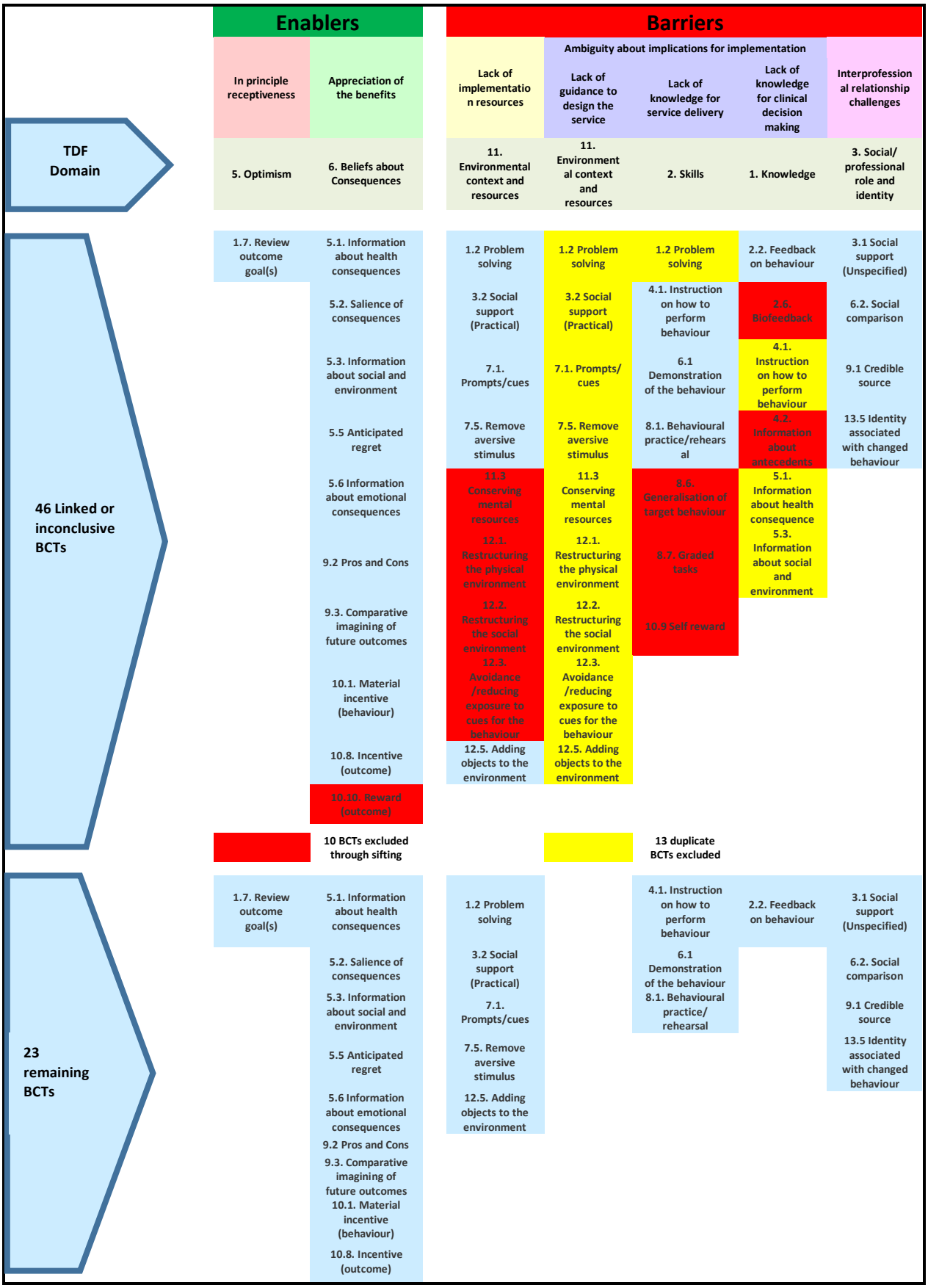
**Links** **Inconclusive or Marginal Link**

As the Environment context and resources domain was mapped with two themes, a total of 46 potential BCTs were noted.

**Stage 3: To select Behaviour Change Techniques using consensus methods for the service intervention.**

Following the mapping of the domains of behaviour onto the Theory and Techniques Tool (TTT), two researchers (TR and SS) undertook a sifting process which eliminated 10 BCTs from the 46 that were deemed as irrelevant/inappropriate for implementation in a community pharmacy setting (supplementary files). Thirteen duplicate BCTs were also removed. As a result, 23 BCTs remained for consideration in the consensus process (Figure 2).

## Figure 2: Sifting and removal of duplicate BCTs



**Pre-workshop survey**

All 23 remaining BCTs were voted on using the APEASE criteria. Following the first round of voting, for nine of the BCTs, there was consensus, with over 80% of participants agreeing for all six APEASE criteria. These are therefore included in the study. For seven of the BCTs, there was only partial consensus, with over 80% of participants agreement on four or five of the criteria. Finally, for the remaining seven BCTs, there was no consensus thus they were subsequently disregarded (supplementary files).

For the seven BCTs where there was partial consensus, participants completed a second round of voting, where they also saw the ratings and comments from other participants. For four of the BCTs there was subsequent consensus, thus they were also included. There was no consensus for the other three BCTs thus they were rejected (supplementary files).

**Workshop**

The consensus group reviewed the 13 BCTs that gained consensus after the two rounds of voting. Following a discussion, and a further round of voting to rank the BCTs, the group agreed to include seven and merge a further two (Table 4).

**Table 4: Outcome from consensus group**

| Barrier/ Enabler | TDF Domain | BCT | Voting decision | Consensus decision |
|---|---|---|---|---|
| In principle receptiveness | 5. Optimism | 1.7 Review outcome goal(s) | Include | Include |
| Appreciation of the benefits | 6. Beliefs about Consequences | 5.3 Information about social and environment | Include | |
| | | 5.6 Information about emotional consequences | Include | Include |
| | | 9.2 Pros and Cons | Include | Include |
| | | 9.3. Comparative imagining of future outcomes | Include | |
| Lack of implementation resources | 11. Environmental context and resources | 1.2 Problem solving | Include | |
| | | 3.2 Social support (Practical) | Include | Include |
| Lack of guidance to design the service | | 7.1. Prompts/cues | Include | |
| | | 12.5. Adding objects to the environment | Include | Include |
| Lack of knowledge for service delivery | 2. Skills | 4.1. Instruction on how to perform behaviour | Include | Merge |
| | | 6.1 Demonstration of the behaviour | Include | |
| Lack of knowledge for clinical decision making | 1. Knowledge | 2.2. Feedback on behaviour | Include | Include |
| Interprofessional relationship challenges | 3. Social/ professional role and identity | 9.1 Credible source | Include | Include |

## Discussion

Complex interventions require a theoretical and evidence-based methodological approach for a successful implementation (17). The frameworks and models deployed were all action orientated and resulted in a pragmatic outcome underpinned by a co-design process. Use of these theoretical framework, models and consensus methods has mapped enablers and barriers to identify nine Behaviour Change Techniques (BCTs) from which a service specification for a pharmacogenomic (PGx) testing service can now be developed.

The first enabler was in-principle receptiveness to PGx testing and this was linked to the Theoretical Domains Framework (TDF) domain of "*Optimism*". The most appropriate BCT was identified as "*Review outcome goal(s)".* Historically, targets have been set for the delivery of community pharmacy services in England, irrespective of the size of the pharmacy, volume of dispensing, demographics of the local community or experience or professional capacity of the pharmacist. An example of this was the Medicine Use Review (MUR) service where all community pharmacies were set an arbitrary maximum target of 400 patient interventions. One of the challenges of outcomes based on numbers is that quality may be driven down. For a new PGx service, having an outcome goal of optimising therapy and improving patient outcomes resulting from the PGx test, with pharmacists sharing and reflecting upon the service outcomes and not pursuing the target number of tests undertaken is desirable. There also needs to be consideration about measures of the outcomes, and procedures in place for collecting the required data.

The second enabler was appreciation of the benefits of PGx testing and the linked TDF domain was *"Belief about Consequences*"; the two preferred BCTs were *"Information about emotional consequences"* and *"Pros and Cons".* In relation to the former, recognising pharmacists' emotional responses surrounding the PGx service was seen as important, particularly as the concept of genomics is a novel area of medicine and pharmacists may perceive that patients' will be worried if they find out that medicines that they have been taking may have been inappropriate. In relation to pros and cons, taking time to list the advantages and disadvantages of offering the service in their already busy schedules could change pharmacists' views about the introduction of new services, rather than it just being additional workload, particularly in a post pandemic world of professional and commercial pressures. This also links to the goal of improving patient outcomes as it reinforces beliefs about consequences, particularly if experiences in offering and delivering the PGx testing services are shared by pharmacists.

The barriers relating to lack of implementation resources and lack of guidance to design the service shared the TDF behaviour domain of *"Environmental context and resources".* The first prioritised BCT for this domain was *"Social support (Practical)"* ensuring that the whole pharmacy team, peers and line managers were fully engaged prior to and during implementation so that they could encourage and fully support the pharmacist; further work to fully characterise this 'support' is required for a service specification. The second BCT was *"Adding objects to the environment"* and recommendations included providing a suite of Standard Operating Procedures, posters and leaflets.

For the lack of knowledge for service delivery barrier, the *"Skills"* behaviour domain was mapped. Two corresponding BCTs were prioritised by the consensus group, namely *"Instruction on how to perform behaviour"* and *"Demonstration of the behaviour".* Following a discussion, it was agreed to merge them into "Instruction and demonstration on how to perform the behaviour". As most community pharmacist work in professional isolation, and often remotely, participants suggestion to develop a suite of training materials and quick reference guides, both supported by short interactive videos could be beneficial to overcome any actual or perceived skills gap in how to confidently offer and deliver the service to patients.

The lack of knowledge for clinical decision making was mapped onto the *"Knowledge"* domain. The linked BCT was *"Feedback on behaviour"* and participants felt it beneficial if they could receive regular summary updates and peer benchmarking information on PGx testing outcomes that they had completed to enable continuous learning and reflection in their practice. Inclusion of patient and prescriber feedback as a quality marker was also seen as beneficial to improving the service.

The final barrier was the pharmacist and prescriber interprofessional relationship and the corresponding behaviour domain was *"Social/ professional role and identity".* The BCT that gained consensus for this domain was *"Credible source"* and in practice participants suggested that this could be by providing the pharmacist research papers and testimonials from Genomics England or The National Institute for Health and Care Excellence (NICE) that they could share as part of an engagement pack with prescribers to give them confidence that the PGx testing service was endorsed by professional bodies. It was also suggested that potential savings could be shared with prescribers to gain their interest.

When the findings from this study are mapped against those that have explored the implementation of PGx services outside the UK there are some commonalities and also

differences. Other studies also suggest the importance of effecting change through providing instruction as to how to perform the behaviour and adding objects - such as SOPs - to the environment. Other BCTs are not evident in previous work (15).

In summary, some very practical suggestions have been proposed as part of this collaborative co-design approach giving a pragmatic basis to produce a service specification for a community pharmacist led PGx testing service in England.

**Limitations**

One limitation is that only a relatively small number of pharmacists participated in the consensus methods. Furthermore, all the participants were purposively sampled and were community pharmacists employed by Day Lewis Plc thus may not be representative of their peer group. In addition, due to the Covid-19 pandemic, the consensus group was held online, and a face-to-face meeting may have generated greater richness in the data. Finally, none of the participating pharmacists had any experience of PGx testing and none had any significant knowledge of genetic medicine or PGx; their understanding was limited to their personal experiences as a community pharmacist working in England and their insights may have been different if they had participated in or visited a community pharmacy that had implemented the service elsewhere in the world.

# Conclusion

This study has used the Behaviour Change Technique taxonomy v1 (BCTTv1) to identify the required behaviours for a service specification for delivery of a community pharmacy based PGx service in England, using outcomes from a previous qualitative analysis (23). This has been achieved utilising theoretical frameworks, tools and consensus methods to identify the desired pragmatic behaviours as part of a co-design process and achieving the aims of this study. There is scope and a real opportunity for a pharmacist led PGx testing service and it should be embraced for the benefit of both patients and the NHS at the earliest opportunity.

# Declarations:

## Ethics approval and consent to participate

I confirm that all methods were carried out in accordance with relevant guidelines and regulations.

This study protocol gained approval from The Research Ethics Approval Committee for Health (EP 19/20 069) at the University of Bath.

I confirm that informed consent was obtained from all the participants.

## Consent for publication

Not applicable.

## Availability of data and materials

The datasets generated and/or analysed during the current study are publicly available in the supporting file.

## Competing interests

Barnett declares that she has no competing interests.

Rendell is Head of Pharmacy at Day Lewis Plc. He is also a Professional Doctorate student at the University of Bath studying PGx and he is Chair of the Operations Board at the Centre for Pharmacy Postgraduate Education, based at the University of Manchester.

Scott declares that he has no competing interests

Wright has a research collaboration with myDNA Life Australia but has no financial interests in the company.

## Funding

Not applicable.

## Authors' contributions

TR was the corresponding author. Throughout, the results were continually analysed over several months with oversight from the co-authors (JB, SS and DW) to discuss and reflect on the results. All authors read and approved the final manuscript.

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Not applicable

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## *Supplementary Data: Sifting of BCTs*

| BCT | Reason for exclusion |
|---|---|
| 10.10. Reward (outcome) | BCT not distinct enough from 10.8 Incentive (outcome) in the context of the desired behaviour. |
| 11.3 Conserving mental resources | Excluded as inappropriate for pharmacists in the context of this study |
| 12.1. Restructuring the physical environment | Physical environment not a barrier to offering or delivering the pharmacogenomics testing service to a patient when they have been prescribed a new medicine in community pharmacy setting. |
| 12.2. Restructuring the social environment | Physical environment not a barrier to offering or delivering the pharmacogenomics testing service to a patient when they have been prescribed a new medicine in community pharmacy setting. |
| 12.3. Avoidance /reducing exposure to cues for the behaviour | Excluded as need to increase exposure of the behaviour, not reduce |
| 8.6. Generalisation of target behaviour | As a community pharmacy service, it is so different to other services offered thus there is no generalisation. |
| 8.7. Graded tasks | It is not possible to part offer the pharmacogenomics testing service to patients when they have been prescribed a new medicine; it is all or nothing. |
| 10.9 Self reward | As healthcare professionals, pharmacists do not need self-reward as part of delivering a pharmacy service. |
| 2.6. Biofeedback | Pharmacogenomic testing does not require any ongoing monitoring or feedback; it is a one-off buccal swab DNA test. |
| 4.2. Information about antecedents | Excluded as not trying to get pharmacists to avoid the behaviour. |

*Supplementary Data: First round of voting online.*

| Key | |
|---|---|
| Include | All > 80% |
| Partial Consensus | 4 or 5 > 80% |
| Reject | Any < 70% |

| BCT | Survey Question | Total | | | | | | Consensus Decision |
|---|---|---|---|---|---|---|---|---|
| | | A | P | E | A | S | E | |
| 1.7 Review outcome goal(s) | 1. Post implementation, line manager to review targets for the pharmacogenomics testing service jointly with the pharmacist and consider modifying them, considering achievement to date e.g., agree the target number of tests to be completed in each pharmacy after having reviewed the first three months activity | 91% | 91% | 64% | 82% | 82% | 73% | Partial Consensus |
| 5.1 Information about health consequences | 2. As part of the training for and set-up of the service, external organization (e.g., CPPE) to provide information to pharmacist about the health consequences for the patient of delivering the pharmacogenomics testing service when they have been prescribed a new medicine (e.g., having a positive therapeutic response or not having adverse side-effects from their prescribed medicines). | 91% | 82% | 91% | 91% | 64% | 91% | Partial Consensus |
| 5.2 Salience of consequences | 3. As part of the training for and set-up of the service, external organisation to provide information to emphasise the consequences of offering pharmacogenomic testing with the aim of making the patient interactions more memorable e.g., produce case studies of patients who have benefited from pharmacogenomic testing. | 73% | 73% | 64% | 91% | 91% | 91% | Reject |
| 5.3 Information about social and environment | 4. As part of the training for and set-up of the service, external organization to provide information to pharmacists about the social and environmental consequences of offering the pharmacogenomics testing service e.g., the societal benefits for themselves (practicing leading edge medicine/providing high quality care) and cost benefits to the NHS. | 82% | 73% | 82% | 100% | 91% | 100% | Partial Consensus |
| 5.5 Anticipated regret | 5. As part of the set-up of the service, line manager/ support pharmacist to ask the pharmacist how they would feel if they do not offer the service to their patients and as a result may not benefit from | 91% | 82% | 82% | 64% | 64% | 55% | Reject |
| 5.6 Information about emotional consequences | 6. As part of the set-up of the service, external organization to provide written, verbal and visual information about emotional consequences of offering the pharmacogenomics testing service e.g., explaining to pharmacist that optimising medication increases health, wellbeing and happiness for patients. | 91% | 100% | 100% | 100% | 91% | 100% | Include |
| 9.2 Pros and Cons | 7. As part of the set-up of the service, line manager/ support pharmacist to advise the pharmacist to identify and compare the reasons for wanting (pros) and not wanting to (cons) offer the pharmacogenomics testing service to patients when they have been | 91% | 91% | 91% | 82% | 91% | 82% | Include |
| 9.3. Comparative imagining of future outcomes | 8. As part of the set-up of the service, line manager/ support pharmacist to prompt the pharmacist to imagine and compare likely or possible outcomes following offering versus not offering the pharmacogenomics testing service to a patient when they have been prescribed a new medicine. | 100% | 82% | 100% | 82% | 82% | 91% | Include |
| 10.1. Material incentive (behaviour) | 9. As part of the set-up of the service, line manager to inform pharmacist that a financial payment will be made by the pharmacy business for each patient participating in the pharmacogenomics testing service following having been prescribed a new medicine. | 82% | 91% | 73% | 91% | 64% | 73% | Reject |
| 10.8. Incentive (outcome) | 10. Post implementation of the service, pharmacy business to arrange for the delivery of a reward if and only if the prescriber accepts their recommendations for a change in prescription following a pharmacogenomic test. | 64% | 73% | 36% | 27% | 45% | 45% | Reject |
| 1.2 Problem solving | 11. As part of the set-up of the service, line manager/ support pharmacist to analyse , or prompt the pharmacist to analyse, factors influencing offering the service and generate or select strategies that include overcoming barriers e.g., prompt the pharmacist to identify barriers preventing them from offering the pharmacogenomic testing service. | 100% | 64% | 91% | 82% | 91% | 91% | Partial Consensus |
| 3.2 Social support (Practical) | 12. As part of the set-up of the service, pharmacy business to arrange, or provide practical help e.g., ensure the line manager/ support pharmacist/ pharmacy team is fully briefed on the pharmacogenomic testing service so that they can give support, help and advice when required. | 82% | 82% | 82% | 91% | 82% | 91% | Include |

| BCT | Survey Question | Total | | | | | | Consensus Decision |
|---|---|---|---|---|---|---|---|---|
| | | A | P | E | A | S | E | |
| 7.1. Prompts/cues | 13. As part of the set-up of the service, pharmacy business to introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour e.g., pharmacy business toprogramme the Patient Medication Record (PMR) to identify every time a new medicine is dispensed and put a sticker on the outside of the completed prescription bag. | 91% | 100% | 91% | 91% | 91% | 91% | Include |
| 7.5. Remove aversive stimulus | 14. Post implementation of the service pharmacy business to arrange for the removal of any aversive stimulus to facilitate behaviour change e.g., line manager/ support pharmacist to stop nagging pharmacists to do more testing to increase the number of pharmacogenomics tests completed. | 73% | 91% | 73% | 100% | 64% | 82% | Reject |
| 12.5. Adding objects to the environment | 15. As part of the set-up of the service, pharmacy business to add objects to the environment to facilitate performance of the behaviour e.g., provide materials including Standard Operating Procedures (SOPs) and posters for the consultation room to help with offering the pharmacogenomics testing service to patients. | 100% | 91% | 100% | 100% | 100% | 100% | Include |
| 4.1. Instruction on how to perform behaviour | 16. As part of the training for and set-up of the service, external organization to advise on and line manager/ support pharmacists to agree on how to perform the behaviour i.e. ., direct the pharmacist "how" to offer the pharmacogenomics testing service to patients when they have been prescribed a new medicine. | 91% | 100% | 91% | 91% | 82% | 82% | Include |
| 6.1 Demonstration of the behaviour | 17. As part of the training for and set-up of the service, external organization to provide an observable sample of the performance of the behaviour e.g., demonstrate to pharmacists "how" to offer the pharmacogenomics testing service to patients when they have been prescribed a new medicine using a short video. | 91% | 82% | 91% | 91% | 91% | 91% | Include |
| 8.1. Behavioural practice/rehearsal | 18. As part of the training for and set-up of the service, line manager/ support pharmacist to prompt practice or rehearsal of the performance of the behaviour one or more times to increase habit and skill e.g., ask pharmacist to rehearse offering the pharmacogenomics service until they feel confident, with appropriate peer or self-accreditation. | 91% | 73% | 82% | 82% | 82% | 82% | Partial Consensus |
| 2.2. Feedback on behaviour | 19. Post implementation of the service, pharmacy business to monitor and provide monthly informative or evaluative feedback on performance of the behaviour e.g., line manager/ support pharmacist provides pharmacist feedback report on pharmacogenomic tests completed including number of medicines recommended for a change and number of prescriber recommendations accepted. | 100% | 82% | 73% | 73% | 82% | 82% | Partial Consensus |
| 3.1 Social support (Unspecified) | 20. Post implementation of the service, line manager/ support pharmacist to advise on, arrange or provide social support performance of the behaviour. e.g., pharmacists participating in the service to form a virtual network to share experience and encourage each other (WhatsApp group, virtual meetings). | 100% | 82% | 73% | 82% | 73% | 73% | Reject |
| 6.2. Social comparison | 21. Post implementation of the service, line manager/ support pharmacist to draw attention to others' performance to allow comparison with the pharmacist's own performance e.g., pharmacist to compile patient case studies, to share with other pharmacists and GPs showing real world benefits of pharmacogenomic testing. | 91% | 64% | 82% | 55% | 55% | 82% | Reject |
| 9.1 Credible source | 22. As part of the set-up of the service, external organisation to prepare verbal or visual communication from a credible source in favour of the behaviour e.g., pharmacist to have information from Genomics England or the Royal Pharmaceutical Society (RPS) to share with GPs how pharmacogenomic testing fits with the NHS long term plan. | 100% | 91% | 100% | 100% | 91% | 100% | Include |
| 13.5 Identity associated with changed behaviour | 23. Post implementation of the service, external organisation (e.g., RPS) to advise the pharmacist to construct a new self-identity as someone who 'is expert with the new behaviour'. e.g., pharmacists offering the pharmacogenomics testing service to be credentialled as specialists in this novel field of medicine. | 91% | 91% | 82% | 82% | 64% | 82% | Partial Consensus |

# *Supplementary Data: Second round of voting online*

| Key | |
|---|---|
| Include | All > 80% |
| Partial Consensus | 4 or more > 80% |
| Reject | Any < 70% |

| BCT | Survey Question - Second vote | Total | | | | | | Consensus Decision |
|---|---|---|---|---|---|---|---|---|
| | | A | P | E | A | S | E | |
| 1.7 Review outcome goal(s) | 1. Post implementation, line manager to review targets for the pharmacogenomics testing service jointly with the pharmacist and consider modifying them, considering achievement to date e.g., agree the target number of tests to be completed in each pharmacy after having reviewed the first three months activity. | | | 82% | | | 82% | Include |
| 5.1 Information about health consequences | 2. As part of the training for and set-up of the service, external organization (e.g., CPPE) to provide information to pharmacist about the health consequences for the patient of delivering the pharmacogenomics testing service when they have been prescribed a new medicine (e.g., having a positive therapeutic response or not having adverse side-effects from their prescribed medicines). | | | | | 55% | | Reject |
| 5.3 Information about social and environment | 4. As part of the training for and set-up of the service, external organization to provide information to pharmacists about the social and environmental consequences of offering the pharmacogenomics testing service e.g., the societal benefits for themselves (practicing leading edge medicine/providing high quality care) and cost benefits to the NHS. | | 91% | | | | | Include |
| 1.2 Problem solving | 11. As part of the set-up of the service, line manager/ support pharmacist to analyse , or prompt the pharmacist to analyse, factors influencing offering the service and generate or select strategies that include overcoming barriers e.g., prompt the pharmacist to identify barriers preventing them from offering the pharmacogenomic testing service. | | 100% | | | | | Include |
| 8.1. Behavioural practice/rehearsal | 18. As part of the training for and set-up of the service, line manager/ support pharmacist to prompt practice or rehearsal of the performance of the behaviour one or more times to increase habit and skill e.g., ask pharmacist to rehearse offering the pharmacogenomics service until they feel confident, with appropriate peer or self-accreditation. | | 64% | | | | | Reject |
| 2.2. Feedback on behaviour | 19. Post implementation of the service, pharmacy business to monitor and provide monthly informative or evaluative feedback on performance of the behaviour e.g., line manager/ support pharmacist provides pharmacist feedback report on pharmacogenomic tests completed including number of medicines recommended for a change and number of prescriber recommendations accepted. | | | 100% | 91% | | | Include |
| 13.5 Identity associated with changed behaviour | 23. Post implementation of the service, external organisation (e.g., RPS) to advise the pharmacist to construct a new self-identity as someone who 'is expert with the new behaviour'. e.g., pharmacists offering the pharmacogenomics testing service to be credentialled as specialists in this novel field of medicine. | | | | | 64% | | Reject |