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PHARMACOGENETIC PANEL TESTING IN SPECIALIZED PSYCHIATRIC CARE - PILOT STUDY

ABSTRACT

Background: *Psychiatric medication response and adverse effects show substantial interindividual variability, partly due to genetic differences in drug metabolizing enzymes, which pharmacogenetics seeks to address to optimize treatment. Although its clinical use has expanded in psychiatry and may improve outcomes and cost-effectiveness, less is known about patient selection and real-world implementation. This pilot study describes pharmacogenetic panel testing in specialized psychiatric care, focusing on patient selection, underlying clinical factors and the testing process timeline.* ***Methods:*** *The study included participants from Oulu University Hospital specialized psychiatric care with individuals identified via the Nordlab laboratory information system. Data was collected manually from the ESKO electronic health record system for participants over 13 years of age who were tested between 1 January and 30 June 2024. Data extracted from patient records included clinical, demographic and testing-related variables.* ***Results:*** *The study included 133 participants who underwent pharmacogenetic panel testing (mean age 32.2 years). The most common diagnoses were unipolar depression (35%) and psychosis (27%). On average, participants had tried 1.33 antidepressants and 1.29 antipsychotics before testing, with antipsychotics being the most used medication group at the time of testing. The main indications for testing were medication optimization, and poor response or adverse effects, however, the indication was not documented in 21% of referrals. The mean time from referral to result availability was 24.8 days and to analysis completion 59.8 days.* ***Conclusions:*** *Pharmacogenetic panel testing appears to be primarily targeted toward general medication optimization and difficult-to-treat psychiatric patients, although the clinical utilization and documentation of test results remain variable. The findings support the need for clearer clinical processes and standardized documentation practices to facilitate the integration of pharmacogenetics into psychiatric care.*

KEYWORDS: PSYCHIATRIC, PHARMACOGENETIC, PANEL, TEST, SPECIALIZED PSYCHIATRIC CARE

INTRODUCTION

There is substantial interindividual variability in the response to psychiatric medications and in the occurrence of adverse effects (1). In clinical practice, patients often undergo multiple medication trials before an effective drug and appropriate dosage are identified. In antidepressant treatment, complete symptom remission is achieved in only approximately 40% of patients (2). Clinical response to first-line antipsychotic treatment is achieved in approximately 60–70% of patients (3).

The process of identifying effective psychiatric medication may be prolonged and place additional strain on both patients and the healthcare system. Interindividual differences in drug response are partly explained by genetic variation in enzymes involved in drug metabolism (4). To identify these genetic variations and to support individualized medication treatment, pharmacogenetics is utilized (5). Pharmacogenetics enables the prediction of drug responses, reduction of the risk of adverse effects and optimization of treatment efficacy. Clinical pharmacogenetics is grounded in research on gene structure, genotyping and genotype–phenotype associations (6). The use of pharmacogenetics in clinical practice has increased in recent years, and its application has expanded to psychiatry. Evidence suggests that pre-emptive genotyping may improve treatment outcomes and cost-effectiveness (7,8). Cost savings arise particularly from a reduction in adverse effects, decreased need for hospitalization and faster achievement of effective treatment (8). The patients who appear to benefit most from testing are those who have had an inadequate response to medication or who experience clinically significant adverse effects (9,10).

Although the clinical utility of pharmacogenetics has been increasingly studied, research has primarily focused on evaluating clinical effectiveness and implementation in healthcare settings (11). In the context of psychiatry, research has mainly concentrated on individual genes and specific drug classes, particularly cytochrome P450 enzymes, CYP2D6 and CYP2C19 enzymes and antidepressant medications (12). In addition, studies have examined the association between these genetic variants and antidepressant response across multiple clinical cohorts (11). Less attention has been given to the practical implementation of pharmacogenetic testing (PGx) in psychiatric clinical practice, including patient selection for testing, clinical indications for testing and the use of results in treatment decision-making (6,11). Systematic evaluation of these processes in psychiatric specialized healthcare remains relatively limited.

The aim of this registry-based pilot study was to describe the PGx testing process in psychiatric specialized healthcare. The study examined which patients and patient groups were referred for PGx testing and the factors leading to such evaluations. In addition, the time required for the PGx testing process from test request to the completion of results and analysis was assessed. The primary research question was: "How is PGx testing implemented in specialized psychiatric care?" The sub-questions are: "Which patient groups were tested, including their sociodemographic characteristics, and why?" and "How much time elapsed from the test request to the completion of results and subsequent analysis?"

MATERIAL AND METHODS

DATA

The pilot study was conducted at the Department of Psychiatry, Oulu University Hospital (OYS Psychiatry). The study population consisted of patients 13 years and older who were treated in OYS Psychiatry, for whom PGx panel testing had been performed between 1st January 2024 and 30th June 2024. OYS Psychiatry consists of psychiatric inpatient wards within a university hospital, adolescent and adult psychiatric outpatient units, the psychiatric emergency unit and regional psychiatric units of Oulaskangas (inpatient ward and outpatient services). Data collection was based on patient identifiers obtained from the Nordlab laboratory information system. The data were collected manually from the ESKO electronic health record system. A total of 133 patients were included in the study, and the only exclusion criteria was age under 13 years.

The data collected from the patient record system are presented in *Table 1*. The data were compiled into a single Excel file for further analysis. Information extracted included the patient's primary psychiatric diagnoses, gender, age at the time of PGx testing and age at disease onset. Data on the patient's psychiatric medication history prior to testing, as well as the current medication list at the time of testing, were also collected. In addition, the indications for PGx testing were recorded, as well as the unit from where the referral to the PGx testing was done. Dates related to the testing process were extracted, including the date of test referral, the date of result availability and the date of completion of the analysis. Furthermore, information on who performed the analysis (pharmacist or physician) was collected. Analysis refers to the process in which the treating physician or pharmacist reviews the patient's medication in relation to the test results and documents the findings in the patient's health record. Finally, it was documented whether and how the PGx test results were mentioned in treatment planning. This was intended to also capture patients for whom no formal analysis had been performed.

STATISTICAL ANALYSES

The statistical analysis of the data was performed using IBM SPSS Statistics software. For continuous variables, the mean and standard deviation (SD) were calculated. These were used to describe age (at the time of PGx testing and age at disease onset), the number of previous psychiatric medication trials and time in the PGx testing process.

For categorical variables, cross-tabulation analysis was performed, and frequencies and percentages were reported. This method was used to analyse indications for PGx testing, current medications at the time of testing, diagnoses, unit from where the referral to PGx testing was done and documentation in patient records.

ETHICAL CONSIDERATIONS

Research permission was obtained from the Wellbeing Services County of North Ostrobothnia (Pohde), along with a data permit (TIEL:32/2025, TUTK:234/2025). In addition, a separate research permit was obtained from Nordlab for the release of personal data. The study was conducted in accordance with the guidelines of the Finnish National Board on Research Integrity (TENK 2023). As the study was a registry-based study, approval from an ethics committee was not required.

Table 1. Data collected from the patient health records

Data	Description
age	age of onset of the psychiatric disorder and age at time of PGx test
gender	male/female
primary psychiatric diagnoses	primary psychiatric diagnosis at the time of referral to PGx test
medication treatments	previous psychiatric medication treatments before PGx testing and at the time of PGx testing
other therapeutic interventions	exposure to ECT, TMS or ketamine treatment
indication/indications for PGx testing	medication optimization, adverse drug reaction, non-response to medication, testing process initiated by the patient
dates of assessment	PGx test request date, sample collection date, result date, analysis completion date
performer of analysis	pharmacist/ physician
clinical documentation	Was the PGx test result documented in the patient record or considered in patient care?

(PGx=Pharmacogenetic, ECT=Electroconvulsive Therapy, TMS=Transcranial Magnetic Stimulation)

RESULTS

SAMPLE

The study sample consisted of 133 individuals (mean age 32.2 years) who underwent PGx testing between 1 January and 30 June 2024. The analyses included test panels 11611 B-Farm-D and 11849 B-PGx-D (*Table 2*). On average, the participants had tried 1.33 (SD=1.48) antidepressants and 1.29 (SD=1.27) antipsychotics prior to PGx testing. The most common primary psychiatric diagnostic groups were unipolar depression 35% (n=46) and psychosis 27% (n=36). Most referrals originated from psychiatric inpatient wards within a university hospital (n=55, 41.4%) and from adolescent and adult psychiatric outpatient care (n=41, 30.8%).

INDICATIONS FOR PGX TESTING, TIME FRAMES AND DOCUMENTATION PROCEDURES

The most common indication for conducting the PGx test was optimization of medication (n=56, 42%) (*Table 3*). Medication optimization refers to all entries in the patient records where the physician indicated that the PGx test was ordered to support treatment planning. Other common indications for conducting the PGx testing were adverse drug effects or poor response to medication. Indication was missing information in one fifth (n=28, 21%) of the PGx test referrals. Polypharmacy was not mentioned as indication for PGx for any of the subjects.

In the study cohort, 52% had their PGx test result recorded in the patient records (*Table 4*). More detailed result analysis had been conducted for 18% of the participants. The average time from referral to the panel to completion of the analysis was 59.8 days (SD=64.6). The average time from referral to ordering the panel and receiving the results was 24.8 days (SD=18.2).

Table 2. Background characteristics of the study population

	Total (n=133)
Background variable	
Female (n, (%))	86 (64.7)
Age (mean, (SD))	32.2 (15.2)
Number of antidepressants before PGx test (mean, (SD))	1.33 (1.476)
Number of antipsychotics before PGx test (mean, (SD))	1.29 (1.265)
Onset age of the psychiatric disorder (mean, (SD))	23.53 (13.06)
Main diagnosis	**n (%)**
Unipolar depression	46 (34.6)
Psychosis	36 (27.1)
Other[1]	33 (24.6)
Anxiety disorder	11 (8.3)
Bipolar disorder	7 (5.3)
Psychiatric medication at the time of PGx test	**n (%)**
Antipsychotic	95 (71.4)
Antidepressant	69 (51.9)
Mood stabilizer (including lithium)	14 (10.5)
Sedatives	33 (24.8)
PGx test referral location	**n (%)**
psychiatric inpatient wards within a university hospital	55 (41.4)
adolescent and adult psychiatric outpatient units	41 (30.8)
psychiatric emergency services	23 (17.3)
psychiatric inpatient ward of a regional hospital	7 (5.3)
outpatient care units of a regional hospital	7 (5.3)

(SD=Standard Deviation, PGx=Pharmacogenetic)
[1] Other most commonly refers to obsessive-compulsive disorders and eating disorders. None of the subjects had substance use disorders as main diagnosis

Table 3. Indications for PGx testing

Indication for PGx test	total n=133, n (%)
Medication optimization	56 (42.1)
Indication not documented	28 (21.1)
Adverse drug reactions (ADRs)	26 (19.5)
Non-response to medication	16 (12.0)
Non-response to medication and ADRs	4 (3.0)
Initiated by the patient	3 (2.3)

(PGx=Pharmacogenetic)

Table 4. PGx testing time frames and documentation procedures

	Total (n=133)
Variable	**n (%)**
PGx test result documented in patient records	70 (52.6)
PGx test result was not analysed, but documented in the patient record	62 (46.6)
PGx test results analysed	25 (18.8)
Time (days) from PGx test referral to result completion mean (SD)	24.8 (18.2)
Time (days) from PGx test referral to completion of result analysis mean (SD)	59.8 (64.6)

(PGx=Pharmacogenetic, SD=Standard Deviation)

DISCUSSION

In this pilot study, the implementation of PGx testing in specialized psychiatric care was examined. More specifically, the study focused on the type of patient groups undergoing testing, the factors leading to testing and how the results were analysed and considered clinically. The study demonstrated that PGx testing particularly targeted patients with a long psychiatric treatment history and multiple previous medication trials. The most common indicated reasons for PGx were medication optimization, and poor response or adverse effects. In addition, testing was most commonly performed in patients diagnosed with psychosis or depression, indicating an emphasis on patients with variable or poor treatment response and variable medication response. The time from laboratory referral to availability of results was nearly one month, and documentation in the patient record took almost two months. There was considerable variability in these time intervals. Most referrals were made at outpatient clinics and hospital wards located near the hospital.

The results are consistent with previous literature, in which pharmacogenetics has been utilized especially in patients with insufficient treatment response or significant adverse drug effects (12,13,14). Previous studies have shown that PGx testing is often directed toward polypharmacy and treatment-resistant patients for whom optimization of pharmacotherapy is challenging (14). The extensive use of antipsychotics and antidepressants prior to PGx testing observed in this study

supports this interpretation. Previous studies have also suggested that pre-emptive PGx testing may reduce adverse drug reactions, improve treatment response and decrease healthcare costs, particularly among psychiatric patients with complex medication regimens (15,16,17). The present findings further support the view that PGx testing is most often utilized in clinically challenging patient populations where medication optimization is particularly relevant.

When examining the indications for testing, the most common indication for PGx test written in the patient health records was optimization of pharmacotherapy, that probably includes insufficient response to medication and/or adverse effects of medication. Surprisingly, polypharmacy was not reported as an indication for PGx in any of the subjects in our sample. However, polypharmacy may still have influenced the decision to refer patients for PGx testing, although this was not explicitly documented in the medical records. It was noteworthy that a significant proportion of tests were performed without a clearly documented indication. This may reflect variability in documentation practices or the possibility that indications for testing are not systematically recorded in patient information systems. This finding highlights the need for more standardized documentation practices in clinical work. Furthermore, the finding raises the question of whether differences in documentation practices and treatment pathways within psychiatry may also be reflected more broadly across the healthcare system, and potentially complicate the interpretation and utilization of patient information in somatic specialized healthcare as well. To our knowledge, the implementation of PGx testing in psychiatric healthcare has been studied only to a limited extent, and previous research has focused primarily on barriers, facilitators and clinical utility rather than on the documentation practices surrounding testing indications and their systematic recording (18).

The clinical utilization of the PGx test results varied. Only approximately half of the PGx test results were clearly documented in patient records, and less than one fifth included a more detailed analysis. This suggests that although the testing itself is being implemented, the systematic use of the results in clinical decision-making has not yet become fully established. Nevertheless, in nearly half of the cases, the results were considered as part of treatment planning, indicating partial integration into clinical practice. Similarly, previous implementation studies have reported that the clinical use of PGx testing results varies considerably: some clinicians actively use the results to support drug selection and dosing, whereas in other cases the results remain undocumented or their impact on clinical decision-making is unclear (14). This reflects the stepwise nature of PGx implementation, with technical availability and clinical integration progressing at different paces (19).

The observed turnaround time for PGx testing in this study is consistent with previous implementation literature. Prior studies have reported that the laboratory phase of pharmacogenetic genotyping typically takes from a few days up to approximately one week, indicating that the analytical process itself is relatively efficient (6,15). In the present study, the average time from test request to result analysis availability was approximately two months, whereas results became available from the laboratory in about one month, suggesting efficiency in the laboratory process itself (Table 4). The overall delay therefore appears to be mainly driven by clinical and organizational factors, such as result processing, documentation and clinical evaluation. This is in line with previous literature emphasizing that key delays in pharmacogenetic implementation are often related to healthcare workflow rather than genotyping itself (6,15).

From a clinical perspective, the findings of this study may support the development of more systematic PGx testing pathways in psychiatric care. The results suggest that clearer criteria for patient selection, more standardized documentation practices and more consistent interpretation of PGx test results could improve the integration of pharmacogenetics into routine psychiatric treatment. In addition, earlier utilization of PGx testing among patients with repeated medication failures or adverse effects may potentially reduce prolonged medication trial processes and improve treatment efficiency.

Interestingly, how and to what extent is PGx testing included in the clinical treatment guidelines? *Table 5* summarizes the recommendations related to PGx testing found in the Finnish Current Care (Käypä hoito) guidelines in the field of psychiatry (20-29). Current Care guidelines do not recommend routine pre-emptive PGx testing, but they may advise considering existing test results or performing testing in cases such as treatment-resistance. Though use of PGx testing is not addressed in many of the guidelines, many of the recommended drugs are such that pharmacogenomic factors may be relevant when treatment is ineffective or adverse effects are unusually severe.

A major strength of this pilot study is the use of real-world clinical data, which provides a realistic view of the practical implementation of PGx testing in psychiatric specialized care. To the best of our knowledge, no previous study has examined the implementation of PGx testing specifically in psychiatric specialized healthcare in this manner. In addition, combining the evaluation of practical testing procedures and patient selection within the same study can be considered a further strength, as it provides a more comprehensive overview of PGx testing

in routine psychiatric clinical practice. Limitations include the retrospective study design and potential deficiencies in patient record documentation, which may particularly affect the accuracy of recording the indications for testing and the reporting of results. In addition, information regarding substance use, and substance-related disorders, was not collected, as it was considered that, given the relatively small sample size, inclusion of these variables would likely not have produced statistically meaningful findings.

The findings of this pilot study can be utilized in clinical practice as well as in the systematic development of PGx testing and the standardization of documentation practices. To conclude, PGx testing seems to be targeted toward general medication optimization and difficult-to-treat psychiatric patients. The clinical utilization and documentation of test results are variable. There is a need for clearer clinical processes and standardized documentation practices to facilitate the integration of pharmacogenetics into psychiatric care.

Table 5. References to the use of pharmacogenetic information in Finnish Current Care Guidelines (Käypä hoito guidelines, the Finnish Medical Society Duodecim, https://www.kaypahoito.fi/en/). The information was collected from the Finnish language guidelines

the Current Care Guideline	How pharmacogenetic information or its use in treatment is presented in the Guideline
ADHD (attention deficit hyperactivity disorder) (20)	Genetic variation in CYP2D6 affects the metabolism of atomoxetine and may influence its plasma concentration.
Anxiety disorder (21)	Pharmacogenetic information improves antidepressant treatment outcomes in depression, but evidence in anxiety disorders is limited; because many medications overlap, testing may help identify atypical metabolism and guide individualized treatment in resistant cases or when adverse effects are unusually severe. Further research is needed to determine the costeffectiveness of broad pharmacogenetic testing.
Depression (22)	Pharmacogenetic information improves antidepressant treatment outcomes in depression. CYP2C19 and CYP2D6 genotyping is justified in treatment-resistant depression to identify atypical metabolism and support individualized medication selection and dosing.
Borderline personality disorder (23)	There is no direct reference to pharmacogenetic information.
Bipolar disorder (24)	In cases of unusually severe, atypical or lowdose adverse effects, pharmacogenetic information may also be applied when relevant. When CYP2D6 genotype is known, it should be considered in dosing aripiprazole, risperidone and haloperidol. Drug level monitoring can help clarify absent response or atypical adverse effects, and CYP2D6 testing may be useful for other CYP2D6 metabolized drugs.
Obsessive-Compulsive Disorder (OCD) (25)	There is no direct reference to pharmacogenetic information.
Schizophrenia (26)	Pharmacogenetic testing may support management of poorly responsive psychosis, particularly with CYP2D6 metabolized antipsychotics or when combining treatment with antidepressants; broader testing still requires costeffectiveness evidence. Drug level monitoring or pharmacogenetic data may help assess unusually severe or atypical adverse effects, although links between CYP polymorphisms and such effects remain inconsistent and need further study.
Eating disorders (27)	There is no direct reference to pharmacogenetic information.
Post-Traumatic Stress Disorder, PTSD (28)	Pharmacogenetic testing can help guide individualized treatment, particularly when drug response is atypical due to significant side effects or insufficient efficacy.
Insomnia disorder (29)	The guideline notes for doxepin that doses below 10 mg generally do not require adjustments for CYP2C19/2D6 variation. Use should be avoided in CYP2D6 ultrarapid metabolizers, while intermediate and poor metabolizers have an increased risk of adverse effects.

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Declarations of interest

None

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