Patients’ and physicians’ perspectives on pharmacogenetic testing

Introduction: The integration of pharmacogenetic testing into routine care will, in part, depend upon the patients’ and physicians’ acceptance of these tests. Empirical data regarding patients’ and physicians’ views on pharmacogenetic testing are lacking. Objectives: To explore patients’ and physicians’ perspectives on the potential implications of pharmacogenetic testing, particularly focusing on asthma, and to analyze the possible determinants of their expectations, hopes and fears. Methods: We conducted telephone interviews with patients with asthma or chronic obstructive pulmonary disease taking part in a larger pharmacogenetic study, in addition to general practitioners (GPs) from a different region in Germany. A total of 328 patients and 378 GPs were invited to participate. Determinants of their attitudes toward pharmacogenetic testing were assessed using logistic regression analysis. Results: Informed consent to participate in this study was given by 196 patients (60%) and 106 GPs (28%). Most patients (96%) and physicians (52%) appreciated the availability of pharmacogenetic tests for a disease such as asthma. Approximately a third of the patients worried about potential unfavorable test results (35%) and violation of privacy (36%). Female patients were more likely to have a fearful attitude (odds ratio [OR] = 2.85; 95% confidence interval [CI] = 1.58–5.12). Younger patients were generally more likely to be hopeful about the usefulness of pharmacogenetic testing (OR = 2.12; CI = 1.01–4.46). The GPs’ concerns were mainly related to the possibility that patients might either be put under pressure to be tested (72%) or be disadvantaged at private health insurance agencies (61%). The nature of the responsible institution, the clarity of the research aim and explicit informed consent from patients influenced a physicians’ decision regarding whether to support a pharmacogenetic study. Conclusion: The concerns of patients and GPs differ somewhat with respect to negative psychosocial consequences, discrimination or violation of privacy. Development of information for physicians and patients would be helpful in preventing unrealistic fears or hopes.

Keywords: attitude of health personnel, delivery of healthcare, ethics, patient acceptance of healthcare, pharmacogenetics

Due to genetic variation, people differ in the transport, metabolism and targets of medications [1]. Pharmacogenetics employs the use of genetic information to facilitate the selection and dosage of medication for individual patients [2-4]. Though pharmacogenetic testing is still under development [5-7], it will become increasingly important in medical care [8]. In the future, pharmacogenetics may permit the administration of an individualized drug treatment [9]. Approximately 100,000 patients worldwide per year are already exposed to pharmacogenetic testing during clinical drug research. In some medical disciplines, such as the diagnosis of coagulation disorders, testing of the underlying causes by molecular genetic means has become almost routine.

However, ethical concerns, including violation of confidentiality, stigmatization and social pressure to accept pharmacogenetic testing, may arise [10]. Pharmacogenetic testing can be distinguished from conventional tests by the fact that the genetic information represents a non-transient individual attribute characterizing, not only the subject being tested, but also to some extent, their family members [11].

There are some genetic variations that indicate not only an insufficient response to medication, but also an increased risk of developing a specific disease, such as Alzheimer’s disease [12]. Affected patients may be at a disadvantage at work and/or health insurance agencies due to unfavorable genetic dispositions that may be associated with increased medical costs or time off work [13-15]. Some authors argue that personal genetic information will inevitably be disclosed to health insurance agencies or pharmacists when patients receive personalized drugs [16]. Many of these issues are shared by both genetic and nongenetic tests [17].

Future implementation of pharmacogenetics in daily medical practice will ultimately depend upon patients’ and physicians’ acceptance of, and
requests for, these tests [18–21]. For most medical conditions, general practitioners (GPs) are a patient’s primary contact, and as such are likely to play a key role in the communication of the necessity and results of pharmacogenetic tests. While many theoretical considerations have been voiced, there is still a lack of empirical data concerning the actual views of patients and GPs [22].

The aims of this study were:

• To explore patients’ and physicians’ expectations, hopes and fears regarding pharmacogenetic testing
• To analyze possible attitude determinants

The results obtained should contribute information regarding the specific perspectives of patients and GPs to pharmacogenetics.

Methods
Study design
A cross-sectional survey based on telephone interviews among GPs and patients with asthma or chronic obstructive pulmonary disease (COPD) was conducted. A questionnaire for patients and physicians, derived from a literature review [22], focused on the psychologic, family-related, social, and ethical consequences of pharmacogenetic testing.

As pharmacogenetic testing is an unknown subject for most patients and some physicians, the study participants were first provided with a standardized information sheet (available upon request). This leaflet gave a definition, an example of pharmacogenetic testing and explained the testing procedure. It also broadly described possible advantages (for example, to find out the best medication dosage) as well as possible risks (for example, violation of privacy). Interviews could then be conducted on a comparable basis.

At the beginning of each interview, the interviewer checked, in a standardized manner, whether or not the patient or doctor had understood the definition of pharmacogenetic testing and repeated the explanations using asthma as an example. Telephone interviews took approximately 15 minutes. The patients’ sociodemographic data, as well as their quality of life [23], had been assessed in the larger study.

The questionnaires
The questionnaires comprised open and closed questions concerning pharmacogenetic-related concerns, hopes and expectations, in addition to other specific aspects, for example privacy issues. A couple of example questions from both the patient and physician questionnaires are given below.

Examples from the patient questionnaire:
• Would you agree to a pharmacogenetic test prior to receiving a prescription for your asthma? ‘yes’/’no’/’don’t know’
• Are you (very/slightly/not) worried about the possibility that a pharmacogenetic test may, by chance, reveal that you possess additional risk factors for another disease that you were unaware of?

Examples from the physician questionnaire:
• Would you recommend a pharmacogenetic test before writing a prescription for asthma? ‘yes’/’no’/’don’t know’
• Are you (very/slightly/not) worried about the possibility that patients may feel ‘different’ or ‘inadequate’ due to an unfavorable test result?

We discussed, revised and piloted the information sheet and questionnaires in order to maximize comprehensibility, neutrality of questions and information received (ten pilot interviews each).

Recruitment of patients & physicians
A total of 328 patients with asthma or COPD were invited to participate. These patients were taking part in a larger study analyzing the association of certain genes and the response to asthma medication. Inclusion criteria were the nonexistence of mental or terminal disease and the ability to understand and speak German.

All GPs who were located in a district in the western part of Germany (Westphalen-Lippe) were contacted by mail (n = 378; not related to participating patients). A prepared reply sheet, on which willingness or reluctance to participate could be noted, was enclosed. Physicians who did not respond to the letter were additionally contacted by phone.

The study protocol has been approved by the University of Göttingen Ethics Committee.

Statistics
The frequency and intensity of patients’ or physicians’ hopes, concerns and expectations in absolute and relative numbers were first calculated. In order to analyze associations between these hopes and worries (criteria) and possible influences (predictors), simple logistic regressions were performed. Therefore, we calculated a sum score for the questions pertaining to hopes and concerns from the patient interviews. We then divided these scores into two
categories as follows. Patients who repeatedly expressed ‘no hope’ (and never ‘great hope’) were regarded as not having a hopeful attitude (sum score of less than 4). Subjects who were consistently ‘unconcerned’ (and were never ‘very concerned’) were labeled as not fearful (sum score of less than 4). Both criteria could be identified by responses to different interview questions. Therefore, having a hopeful attitude regarding pharmacogenetic testing did not preclude being fearful with respect to issues arising from pharmacogenetic testing in general, for example protection of privacy. With regard to physicians’ concerns, a sum score greater than 3 represented a fearful attitude.

Odds ratios (ORs) and their 95% confidence intervals were calculated to estimate the associations between the potential predictors and criteria. For patients, predictor variables included age, gender, education, place of residence, and quality of life. For physicians these were age, gender, place of residence, and size of practice.

Multiple logistic regression analyses were unnecessary as only one variable was significant (p < 0.05) in simple logistic regression. The Statistical Analysis Software (SAS, NC, USA) package, Version 9.1 was used for data analysis.

Results

Sample

A total of 196 patients (60% of 328 patients addressed) and 106 GPs (28% of 378 GPs) agreed to participate by written informed consent (Figure 1). 55% of the patients were female; the mean age of the patients was 57.6 years (range: 23.9–81.2; median = 60.7). We found no evidence of systematic differences (for example, with respect to age, gender or duration of illness) between participating and nonparticipating patients.

Figure 2 shows the process of recruitment of GPs. The main reasons given for physicians’ nonparticipation were either ‘no time’ (92/242, 38% of the refusing GPs), ‘no interest’ (32%) or ‘nonparticipation as a matter of principle’ (17%). In the physician sample, 25% were female. Compared with German reference data (provided by the National Association of Statutory Health Insurance Physicians [101]), participating GPs were more likely to be male, but this did not differ from participation records from other primary care studies [24]. The age distribution was as follows: 8%: 30–40 years, 42%: 40–50 years, 37%: 50–60 years, 14% > 60 years.

Consent to pharmacogenetic testing & expectations

The patients’ view

The vast majority of patients (95.9%; 95% confidence interval [CI] = 92.1–98.2%) would accept pharmacogenetic testing prior to receiving a prescription for asthma medication. Only three of 196 patients would decline testing and five patients were undecided. Nearly 80% (153/196) of the patients wanted to be informed specifically by their GP (13.3% by a specialist; 7.7% by a geneticist).
The patients were optimistic that pharmacogenetic testing would prevent them from taking an inappropriate or second-rate medication (Figure 3). Identifying the drug which would help most, and avoiding side effects, were other important issues. Almost all patients (94.4%; 90.2–97.2%) felt it would be advantageous to know their genetic disposition.

The physicians’ view

Approximately half of the GPs (55/106; 51.9%; 42.0–61.7%) said they would recommend a pharmacogenetic test before administering an anti-asthma drug (for example, β-mimetics) if the fees were covered by the health insurance. Most physicians regarded it highly probable (29.3%; 20.8–38.9%) or rather probable (36.7%; 30.0–43.9%) that a pharmacogenetic test may detect which drug (or which dose) works best? The basis for their view was that their patients’ compliance was affected by the side effects of the currently used drug (35.7%; 29.0–42.9%).
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(53.8%; 43.8–63.5%) that information from pharmacogenetic testing would facilitate the choice of drug or its dosage (14.2% thought it rather improbable; 2.8% very improbable). Compared with patients, fewer physicians (58.5%; 48.5–68.0%) saw an advantage in knowing one’s genetic disposition.

Concerns & expectations
The patients’ view
Patients were asked to give their opinions on five statements concerning possible concerns regarding pharmacogenetic testing (Figure 4). The possibility that a pharmacogenetic test might produce an adverse result, such as the lack of a suitable drug, worried 72% of the patients. Patients were also anxious that information obtained from pharmacogenetic tests might not be sufficiently protected. In contrast, only a few patients were worried that genetic information would be disclosed to health insurance agencies or that the results of pharmacogenetic tests could influence a physician’s prescribing decision less significantly than the results of pharmacogenetic tests.

Should privacy not be protected, approximately 70% of the patients expected problems at work, or with an application for employment if a test result be unfavorable. Fewer respondents expected disadvantages at health insurance agencies (Figure 5). While most patients did not anticipate feeling ‘different’ or ‘inadequate’ when confronted with an adverse test result, 40% expected to at least feel ‘pessimistic’ and ‘helpless’ in such a situation. The majority of patients did not expect to be put under pressure to accept pharmacogenetic testing in the future.

In absence of an alternative drug, more than half of the patients (111/196; 56.6%; 49.4–63.7%) would take a particular drug even if it precluded by a pharmacogenetic test. (if a test revealed that the only drug available would either be ineffective or cause severe side effects, would you try the drug anyway or accept the result of the test?). Approximately 40% (79/196; 33.4%–47.5%) of the patients admitted that they did not completely comprehend the consequences of pharmacogenetic testing.

Among patients, only one factor – being female – was significantly associated with having a fearful attitude toward pharmacogenetic testing (OR = 2.85; 95% CI = 1.58–5.12; Table 1). Age was the only significant predictor for a hopeful attitude regarding pharmacogenetic testing, with younger patients being more optimistic (OR = 2.12; 1.01–4.46).
The physicians’ view

Physicians were asked to give their opinion to four statements regarding possible worries (Figure 6). Many of them feared that employers or insurance agencies might exert pressure on patients to agree to pharmacogenetic testing, and that patients might be disadvantaged at private health insurance agencies if a pharmacogenetic test showed that they needed an exceptionally high dose of a drug. To a lesser degree, they were concerned about how patients might react in the face of adverse testing results, including the possibility that risk factors for another disease such as Alzheimer’s might be revealed.

With respect to predictors of physicians’ worries, only the place of residence tended toward significance: physicians working in a rural area were more likely to have a fearful attitude than physicians from urban regions (OR = 2.16; 0.89–5.25; p = 0.09).

Perspectives on pharmacogenetic research

Most physicians (77.4%; 68.2–84.9%) would rather agree to pharmacogenetic studies if they were conducted by a university (22.6% considered the institution irrelevant; no doctor indicated a preference for studies to be performed by the pharmaceutical industry). More than 70% (76/106; 62.1–80.0%) would encourage their patients to take part in well-controlled pharmacogenetic studies with a clear hypothesis if privacy was guaranteed (13.2% would advise against; 15.1% had no opinion). In contrast, many physicians (64.2%; 54.3–73.2%) would advise patients against participation if the research aims and hypotheses were unspecified (22.6% would encourage participation; 13.2% had no opinion). In any case, physicians (85.9%; 77.7–91.9%) thought that explicit permission and informed consent from patients was necessary before performing a pharmacogenetic test (12.3% thought that this was not necessary; 1.9% did not know).

Discussion

Nearly all patients of our sample would consent to a pharmacogenetic test prior to treatment in the hope that a targeted medication would be prescribed, that side effects could be prevented and the use of ineffective drugs avoided. Approximately half of the GPs would recommend a pharmacogenetic test. GPs voiced greater concerns than patients, especially with respect to pressure being exerted on patients to agree to a pharmacogenetic test or disadvantages at private health insurance agencies.
Table 1. Predictors for the hopes and fears of patients toward pharmacogenetic testing.

<table>
<thead>
<tr>
<th>Predictors for a fearful attitude</th>
<th>Prevalence N (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>p-value</th>
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</thead>
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<tr>
<td>Age (years):</td>
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<tr>
<td>&gt;median (60.7)</td>
<td>42 (42.86)</td>
<td>1</td>
<td></td>
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<tr>
<td>&lt;median</td>
<td>50 (51.02)</td>
<td>1.39</td>
<td>0.79–2.44</td>
<td>0.25</td>
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<td>Gender:</td>
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<tr>
<td>Male</td>
<td>29 (32.95)</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Female</td>
<td>63 (58.33)</td>
<td>2.85</td>
<td>1.58–5.12</td>
<td>0.0005</td>
</tr>
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<td>Place of residence:</td>
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<td>Rural</td>
<td>51 (45.95)</td>
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<tr>
<td>Urban</td>
<td>41 (48.24)</td>
<td>1.10</td>
<td>0.62–1.93</td>
<td>0.75</td>
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<td>Education:</td>
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<td></td>
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<tr>
<td>≥secondary school**</td>
<td>40 (46.51)</td>
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<tr>
<td>&lt;secondary school</td>
<td>52 (47.27)</td>
<td>1.03</td>
<td>0.59–1.82</td>
<td>0.92</td>
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<td>Quality of life:</td>
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<tr>
<td>SGRQ &gt;median (poor)</td>
<td>40 (42.55)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGRQ &lt;median (good)</td>
<td>52 (50.98)</td>
<td>1.40</td>
<td>0.80–2.47</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Predictors for a hopeful attitude*

<table>
<thead>
<tr>
<th>Predictors for a hopeful attitude</th>
<th>Prevalence N (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>p-value</th>
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<tr>
<td>Age (years):</td>
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<tr>
<td>&gt;median (60.7)</td>
<td>74 (75.51)</td>
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<tr>
<td>&lt;median</td>
<td>85 (86.73)</td>
<td>2.12</td>
<td>1.01–4.46</td>
<td>0.05</td>
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<td>Gender:</td>
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<tr>
<td>Male</td>
<td>68 (77.27)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>91 (84.26)</td>
<td>1.57</td>
<td>0.77–3.23</td>
<td>0.22</td>
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<td>Place of residence:</td>
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<tr>
<td>Rural</td>
<td>88 (79.28)</td>
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<td></td>
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<tr>
<td>Urban</td>
<td>71 (83.53)</td>
<td>1.33</td>
<td>0.64–2.76</td>
<td>0.45</td>
</tr>
<tr>
<td>Education:</td>
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<tr>
<td>&lt;secondary school**</td>
<td>87 (79.09)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥secondary school</td>
<td>72 (83.72)</td>
<td>1.36</td>
<td>0.65–2.83</td>
<td>0.41</td>
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<td>Quality of life:</td>
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<tr>
<td>SGRQ &gt;median (poor)</td>
<td>76 (80.85)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGRQ &lt;median (good)</td>
<td>83 (81.37)</td>
<td>1.04</td>
<td>0.51–2.12</td>
<td>0.93</td>
</tr>
</tbody>
</table>

*Attitude evaluation is based on answers to different sections of the questionnaire, so that the same patient may have both a positive attitude toward certain aspects of pharmacogenetic testing as well as negative opinions regarding other points (see methods section for details).

**“Hauptschulabschluss”, i.e. exam passed after 5 years at secondary school.
CI: Confidence interval; N: Number; OR: Odds ratio; SGRQ: St George’s Respiratory Questionnaire.
Limitations

It is possible that the patient sample might be biased, as the patients were already participants in a larger study on pharmacogenetic testing. We can therefore hypothesize that our participants were possibly more open-minded toward pharmacogenetics and better informed than the average patient. Nevertheless, they had typical objections with respect to the regulatory framework, for example, protection of privacy. However, patients with a chronic disease are the target group for pharmacogenetic testing and, consequently, their opinion is exceptionally relevant for the implementation of pharmacogenetics into routine care.

Although the GPs’ response rate was relatively low, it was comparable with other primary care-based studies [24]. The physicians’ appraisals might have been different if another indication for a pharmacogenetic test had been used, for example, a severe and more difficult to treat disease. Nevertheless, asthma is commonly regarded as a suitable indication for pharmacogenetic testing as it represents a chronic illness requiring long-term pharmacologic intervention [25,26].

The provision of an information leaflet might have influenced responders’ opinions in both directions. Whereas the idea of future therapeutic options itself might have favored an optimistic attitude of patients, the physicians’ appraisal of the usefulness of a pharmacogenetic test may have been higher had more detailed information regarding the specificity, sensitivity and the clinical value of a pharmacogenetic test, for example, been included. However, like other researchers [27] we believed that the inclusion of some basic information was essential due to the lack of familiarity with the topic. Therefore, it was of special importance to describe the process of data collection on a systematic and transparent basis and to keep this in mind in interpreting the results.

The patients’ perspective

Patients’ enthusiasm toward pharmacogenetic testing corresponds with results from studies on genetic testing which found a generally high acceptance of these procedures, especially from ill or at-risk persons [28,29]. However, a recent qualitative work disclosed concerns regarding the costs of ‘tailor-made drugs’ compared with conventional treatments and the potential local or global inequalities that may result [30]. As hypothesized by many authors [13–15], patients in our study also worried about privacy issues, and adverse treatment at work or from health...
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insurance agencies. However, in contrast to common assumptions, most patients did not anticipate experiencing negative feelings as a consequence of an unfavorable test result.

Responding patients seemed to have a more simplistic understanding of pharmacogenetic testing than GPs. Indeed, genetic variation is often only one of many explanatory factors (e.g., nutrition, smoking status, and renal function) and may be overestimated by patients without proper information [31,32]. Obviously, patients assume that they will receive a clear and positive treatment recommendation based on pharmacogenetic testing. However, when a particular drug is not recommended and no alternative treatment exists, more than half of the patients would take the inappropriate drug against pharmacogenetic advice, obviously in order to personally check the ‘validity’ of the test result. This scenario poses new challenges for shared decision making in primary care [33].

Approximately 40% of the patients admitted that they might not completely comprehend the scope and consequences of pharmacogenetic testing. As all patients gave written consent to participate in a pharmacogenetic study, it is remarkable that many patients stated limited understanding later on. This knowledge gap emphasizes the importance of future patient education in research and routine practice [8].

Female patients were more likely to have concerns regarding possible negative consequences of pharmacogenetic testing; and younger patients were more likely to be optimistic that pharmacogenetic tests would improve treatment. This partly agrees with studies demonstrating that older people are in general more anxious about genetic testing [29]. Such patients presumably have had the experience that the selection of a medication was the result of trial and error, rather then via directed (pharmacogenetic) testing. In contrast, younger patients obviously hope to accelerate the choice of medication using pharmacogenetic procedures and may be more accepting of technological progress [34]. It is interesting that education and the perceived severity of illness, as assessed by a quality of life measure, did not influence patient attitude toward pharmacogenetic testing.

The GPs’ perspective
The GPs were more reserved toward pharmacogenetic testing than patients. This attitude is in line with the finding that merely describing a test as genetic (in contrast to a serum protein-based test) results in an 11% reduction in physicians’ adoption of such tools, such as for the choice of the right drug for smoking cessation [35,36]. Indeed, pharmacogenetic tests are clinically performed to a lesser degree than expected [37]. Possible reasons for this reservation can be inferred from studies regarding predictive genetic testing that indicate that GPs worry about being confronted with a ‘therapeutic gap’ – in possession of genetic information but with no treatment option [38,39]. Also, experts from Europe and North America, such as academics and consumer representatives, appeal for a profound evaluation of the utility of pharmacogenetic tests in clinical decision making prior to

### Table 2. Predictors for a fearful attitude of physicians toward pharmacogenetic testing.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Prevalence N (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
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<tr>
<td>Age (years)</td>
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<td>&lt;50</td>
<td>37 (71.15)</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>&gt;50</td>
<td>40 (74.07)</td>
<td>1.16</td>
<td>0.49–2.72</td>
<td>0.74</td>
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<td>Gender</td>
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<td>Female</td>
<td>19 (70.37)</td>
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<tr>
<td>Male</td>
<td>58 (73.42)</td>
<td>1.16</td>
<td>0.44–3.05</td>
<td>0.76</td>
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<td>Place of residence</td>
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<td>Urban</td>
<td>36 (65.45)</td>
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<td></td>
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<tr>
<td>Rural</td>
<td>41 (80.39)</td>
<td>2.16</td>
<td>0.89–5.25</td>
<td>0.09</td>
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<tr>
<td>Size of practice</td>
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<tr>
<td>&lt;median</td>
<td>41 (70.69)</td>
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<td></td>
</tr>
<tr>
<td>&gt;median</td>
<td>36 (75.00)</td>
<td>1.24</td>
<td>0.52–2.95</td>
<td>0.62</td>
</tr>
</tbody>
</table>

CI: Confidence interval; N: Number; OR: Odds ratio.
their integration into routine practice [40]. However, GPs seem to balance the risk of discrimination, economic cost and possible disadvantages at health insurance agencies [41] against positive reasons for testing [42]. In a further study using open questions we aim to analyze in more depth the physicians’ personal motives behind their rather reserved attitude, and in particular aim to elucidate how this is influenced by the specific properties and indications of a pharmacogenetic test.

GPs in our study seemed to be more open-minded toward basic pharmacogenetic research than routine pharmacogenetic testing. This readiness to support research corresponds with the attitudes of the lay public [43]. Approximately 80% of the GPs thought that informed consent prior to a pharmacogenetic test was indispensable. Whether this conviction will be reflected in future medical routine is not yet clear [44]. Therefore, the results presented in this paper may be interesting not only for the future of pharmacogenetic and genomic testing in general medical practice, but also for all those who are currently performing pharmacogenetic studies.

Conclusion & outlook

Implementation of pharmacogenetic testing into routine care will pose new challenges to patients and the GPs who have to decide on the application of these tests [45]. If prospective, randomized controlled trials establish pharmacogenetic testing to be cost-effective in primary care [46-48], patients’ and physicians’ worries have to be addressed. Development of information for physicians and patients would be helpful in preventing unrealistic hopes and fears.

Acknowledgments

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Bibliography

Papers of special note have been highlighted as either of interest (•) or of considerable interest (*****)


**Excellent review of the ethical issues of pharmacogenomics and how they affect individuals, groups, industry and society.**


**Qualitative study providing an insight into general practitioners’ concerns related to the integration of genetic services into routine care.**


**One of the few empirical studies about the public acceptance of pharmacogenetics.**

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**Website**

101. KBV website. www.kbv.de

www.futuremedicine.com