Knowledge, Attitude, Future Expectations, and Perceived Barriers of Medical Students and Physicians Regarding Pharmacogenomics in Jordan

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Abstract

Background: Pharmacogenomics (PG) is a modern tool of personalizing treatment protocols to improve the efficacy and safety of drug prescriptions. These benefits are offset by a slow uptake in clinical application due to a host of physician factors, patient factors, and/or health system factors. Our study, thus, aimed to determine the knowledge, attitude, future expectations, and perceived barriers of medical students and physicians in Jordan regarding PG testing. Methods: A descriptive, cross-sectional study was conducted between February-August 2019. Physicians and senior medical students from academic and non-academic institutions in North Jordan (n=424) were surveyed. A structured, self-administered questionnaire was designed and piloted for the purpose of the study. A scoring system for each dimension assessed was calculated and presented using means. Mean scores were compared by sociodemographic and professional variables. Results: The response rate was 70.7%. The mean total PG knowledge score (±SD) was 5.42 (±1.51) out of 10, with a significantly higher mean among respondents aged [?]30 years (5.21 +- 1.62) compared to those <30 years-old (5.54 +- 1.43; p= 0.03). The mean total PG attitude score was 21.18 (+-2.58) out of 24, with significant differences by seniority levels evident (p= 0.03). The future expectations of PG among our sample were high, with a mean score of 10.44 (+-1.64) out of 12. The top three perceived barriers in applying PG were the high cost, lack of clinical guidelines, and limited knowledge and awareness. Conclusion: Physicians and medical students in Jordan have low overall knowledge, albeit strongly positive attitude and future expectations toward PG, despite the perceived high cost and lack of clinical guidelines. Thus, we strongly recommend adopting a comprehensive educational strategy that aims to integrate PG concepts into medical curricula, and promote the culture of continuous medical education about PG among practitioners.

Keywords: Pharmacogenomics, PG, KAP, Jordan, Personalized Medicine, Survey

What is already known about this topic?

Pharmacogenomics (PG) is a tool of personalizing treatment protocols to improve the efficacy and safety of drug prescriptions. These benefits are offset by a slow uptake in clinical application due to limited resources and poor understanding of PG among healthcare providers, particularly in developing countries like Jordan.

What does this article add?

Physicians and medical students in Jordan have low overall knowledge, albeit positive attitude and future expectations toward PG, despite the perceived high cost and lack of clinical guidelines. Our results call for an urgent national educational/training strategy about PG.

Introduction

Inter-individual variability in pharmacological responses to medications poses a significant burden on the capacity of healthcare systems worldwide[1]. The modern concept of "personalized medicine" aims at its core

to facilitate selecting the right drug for the right patient at the right dose with the minimum of adverse drug reactions (ADR)[2]. ADRs are a serious cause of hospitalizations and deaths in the United States[3].The percentage of patients who respond positively to their medications ranges from 25-60%[4]. Almost 40% of patients suffer from a treatment failure, in the form of negative therapeutic effects and negligible desired benefits, necessitating switching from one medication to another[5].

Non-genetic factors, such as age, weight, gender, co-morbid disease states, and drug-drug interactions, are well-documented to contribute to such variability in clinical responses to drugs[6]. However, genetic variation among individuals remains a principal cause of the heterogeneity of drug responses in practice[7]. Hence, pharmacogenomics (PG), the integrated analysis of the role of genomics on responses to drugs[8], is a promising new approach that targets tailoring therapeutic regimens based on a person's genetic makeup[9], thus improving the efficacy and safety of drug prescriptions[10], avoiding ADRs[11], and enhancing patient health outcomes[12]. Most importantly, PG has an immense potential for improving cost-effectiveness of pharmacotherapy[13] .

To date, more than 100 medicines have been included in the Food and Drug Administration (FDA) repository of drugs labeled for PG analysis prior to administration[14], particularly those with a narrow therapeutic index and a fatal toxic potential[15], such as antineoplastic[16], anticonvulsant[17], and anticoagulant drugs[18]. However, there remains a slow uptake of PG applications in mainstream clinical care[19], and many of the FDA-recommended PG tests are unfortunately not in routine use[20]. Although criteria for proper clinical actionability of a novel test fundamentally apply to the available PG tests[21], including analytic validity[22], clinical validity[23], and clinical utility[24], the alarming limited knowledge and awareness of PG concepts among healthcare providers seem to critically hinder its application[25].

The responsibility of healthcare providers in improving the overall quality of clinical care has incentivized recent efforts to integrate PG testing in clinical practice[26]. Pharmacists and physicians alike are nowadays aware of the need to adjust their clinical roles to become more patient-oriented towards enhancing implementation of personalized pharmacotherapy services[27]. However, limited resources and poor understanding of PG persist to be a problem in developing countries like Jordan[28]. Furthermore, there are currently no comprehensive studies exploring correlates of PG practice among the whole stratum of medical students, interns, residents, and specialists, from all fields of medical practice in Jordan. Thus, this study aimed to assess the knowledge, attitude, future expectations, and practice of medical students and clinicians in hospitals in Northern Jordan regarding PG testing, in addition to determining their perceived barriers to its application.

Methods

Study design, population, and settings:

A descriptive, cross-sectional study was conducted in the period February to August 2019. The study population included senior medical students in their 4th year of study and above at Jordan University of Science and Technology (JUST) and Yarmouk University (YU), in addition to interns, residents, general practitioners (GP), and specialist doctors. Study settings included academic institutions like King Abdullah University Hospital (KAUH), hospitals of the Ministry of Health (MOH) and the Royal Medical Services (RMS), private clinics and hospitals, and Non-Governmental Organizations (NGOs) in Northern Jordan. A questionnaire was specifically developed and piloted for the purpose of this study. Face-to-face interviews were carried out with eligible participants to explain the aim of the study, collect the informed consents, and to distribute the questionnaire.

Sampling technique:

All senior medical students, interns, residents, GPs, and specialists studying or working in the above stated hospitals were eligible to participate in the study. Multi-stage sampling technique was used to recruit eligible participants. Students from the two participating medical schools were approached before their lectures and asked to participate. Those who agreed to take part in the study where scheduled for an interview. One teaching hospital (KAUH), three MOH hospitals, and two RMS hospitals, representing all major hospitals

in North Jordan, were utilized to recruit interns, residents, GPs, and specialists. Two days of the week were randomly selected to recruit participants from the major departments/division within each hospital. During which, the researcher randomly approached eligible participants before attending their clinics and asked them to participate. Those who agreed to take part in the study were scheduled for an interview. Physicians in private clinics and NGOs in the geographical area were also recruited by the same procedure.

Study questionnaire:

A structured questionnaire was used to collect the study data. The questionnaire was adapted from several instruments used elsewhere considering the aim of the current study[29-34]. Face and content validity of the questionnaire was achieved through an expert panel of physicians, pharmacists, and biostatisticians. The questionnaire was then piloted in a sample of 20 doctors and 20 students and necessary edits were made. Those were not included in the final results.

The questionnaire consisted of five main sections with a total of 35 questions; sociodemographic characteristics, PG knowledge, attitudes, future expectations, and barriers to practice. Sociodempgraphics included questions regarding age, gender, level of seniority, and primary work setting of the respondents. PG knowledge was assessed using ten questions covering general information about PG, such as definition, availability in Jordan, and inter-individual gene variation. Attitudes towards PG were assessed using eight questions regarding the proposed clinical and therapeutic advantages of PG testing. Future expectations and practice questions (n=4) identified drugs with current and/or potential PG application. Nine barriers to practicing PG were utilized to identify the top perceived barriers to practice PG.

Scoring technique:

Responses to knowledge questions were presented on a 2-point scale format, and scored as either 0 (when incorrect) or 1 (when correct). Total knowledge score ranged from 0 to 10 and was calculated by summing responses to the ten knowledge questions. For the attitudes, responses were scored on a 3-point Likert scale ranging from "agree" (coded as 3), to disagree (coded as 1). Total attitude score, ranging from 0-24, was calculated as indicated above. For the future expectations and practice section, responses were scored on a 3-point Likert scale as follows: "agree" (coded as 3), "neutral" (coded as 2), and "disagree" (coded as 1). The total future expectations and practice score ranged from 0-12, representing the sum of total scores of the four statements in this section. For the barriers section, responses were coded as no or yes.

After scoring of items, and in order to elucidate the effect of seniority and exposure to up-to-date medical advancements on the perceived knowledge, attitude, and future expectations of PG, we stratified respondents based on age, using a cutoff point of 30 years.

Statistical analysis:

Data analysis was performed using the Statistical Package for Social Sciences (SPSS) program version 23 (IBM Inc., New York, USA). Descriptive statistics were employed for analysis. Categorical variables were presented as proportions and frequencies. T-test and One-Way Analysis of Variance (ANOVA) were performed to compare mean scores by demographic and professional variables. P-value of less than 0.05 was considered statistically significant.

Results

Characteristics of study respondents:

Of the 600 questionnaires distributed, only 424 were completed, with a response rate of 70.7%. As shown in Table 1, the sample included 127 medical students (30%), 44 interns (10.4%), 34 GPs (8%), 110 residents (25.9%), and 109 specialists (25.7%), representing academic institutions (50.2%), the MOH (18.2%), the RMS (18.6%), private clinics and hospitals (9%), and NGOs (4%). The majority of respondents were less than 30 years of age (63.2%).

Knowledge of PG:

The mean total knowledge score (±SD) for respondents was 5.42 (±1.51) out of 10. Of interest, about three quarters of participants were aware of the commercial availability of PG tests in Jordan (n = 317, 74.8%). No significant differences in the mean total knowledge scores were detected by gender (p=0.84), seniority level (p= 0.45), and by primary work settings (p= 0.19), as shown in Table 2. Significant differences were detected in the mean knowledge score by age, as respondents [?]30 years old had significantly higher mean score (5.21 +- 1.62) compared to their counterparts in the <30 years group (5.54 +- 1.43; p= 0.03), as detailed in Table 2.

Attitude toward PG:

The mean (+-SD) total attitude score was 21.18 (+-2.58) out of 24. The vast majority of respondents had a positive attitude on all surveyed attitude items. For instance, approximately 77% of respondents agreed that PG testing will help to improve drug efficacy, 72% believed that it will help to decrease the time it takes to find the optimal dose of a drug, and almost 77% agreed that it will enable them to effectively control drug therapy expenditures. Encouragingly, 64.2% of our sample expressed interest in attending training sessions or workshops on PG in the future.

Moreover, there were no significant differences in mean total attitude score based on gender (p=0.13), age groups (p= 0.19), or primary work settings (p= 0.35). However, stratifying respondents according to seniority levels showed a significant difference in mean total attitude score, as the specialist physicians were found to have a higher mean attitude score (21.69 +- 2.54) compared to residents (20.57 +- 2.65;*p=0.03*), as detailed in Table 2.

Future expectations and practice of PG:

Overall, the mean total future expectations and practice score of PG among respondents was 10.44 (+-1.64) out of 12. There were no significant differences in the mean total future expectations and practice score between males and females (p=0.83), or for respondents aged [?]30 versus those aged <30 (p= 0.05), as shown in Table 2. However, classifying respondents based on the various primary work settings revealed a significant difference in mean total future expectations and practice score (p= 0.01), as outlined in Table 2.

Perceived Barriers to Applied PG Testing in Jordan:

Our study had the advent of gauging the perceived barriers to practice of PG testing in Jordan by clinicians and medical students (Table 3). The majority of respondents (90.1%) voted that the prohibitive high cost of PG testing is the most important barrier to practice PG in Jordan, followed by lack of clinical guidelines (88.4%), limited provider of knowledge and awareness (86.8%), and lack of insurance coverage (83.7%). Other less frequent perceived barriers by our sample included: lack of time and resources to educate patients (76.9%), result takes too long for treatment decisions (74.3%), patients' anxiety regarding test results (55.9%), and that test results will not likely affect the treatment decision-making process (31.4%). Intriguingly, a minority of clinicians and medical students (39.6%) believed that their cultural and/or religious beliefs would affect the clinical practice of PG in North Jordan.

Discussion

The use of PG testing in clinical practice essentially aims to optimize treatment protocols, minimize the frequency of ADRs, and generally improve therapeutic outcomes[35]. Since physicians are the most valuable source in passing medical information to patients[36], they should have a basic understanding of PG and conceptualize its validity. Ideally, physicians should also be aware of the most recent advancements in PG research. Our study, therefore, took impetus from this fact, and gauged the knowledge, attitude, and practice of PG among medical students and clinicians in different academic and non-academic health sectors, in addition to identifying the perceived barriers to its future application. The major highlight of this study is that physicians and medical students in North Jordan have, overall, low knowledge, however strongly positive attitude and future expectations toward PG, in spite of the perceived high cost and lack of clinical guidelines.

Despite our finding of poor overall knowledge about PG among medical students and physicians, a deeper look into knowledge items suggests a promising future for PG in Jordan. Indeed, the majority of respondents were aware of PG and its importance in clinical practice, and the foreseen benefits on pharmaco-economy. Almost two thirds of the respondents were aware that PG tests are available in Jordan and could identify which medications require a genetic testing. Therefore, our results should be discussed in the wider context of novelty and recent emergence of PG as a concept. Poor overall knowledge of PG was actually evident in several similar studies around the world. For instance, Elewa*et al.* showed in 2015 a low mean awareness score among Qatari doctors and pharmacists about PG[29]. Furthermore, Abdela *et al.* reported in 2017 a generally low knowledge about PG among Ethiopian healthcare providers[33]. Similar results were additionally obtained from India[37] and Kuwait[34].

Interestingly, stratifying our respondents based on age using a cutoff point of 30 years revealed a significant difference in the mean total PG knowledge score between the younger and older generation. Those below 30 years of age were significantly more knowledgeable about PG than those above 30 years of age. This interesting finding could in part be attributed to the wide access and reliance of the younger generation on the modern and advanced means of education and learning, such as the social media applications and the various reputable open educational resources. Furthermore, one cannot overlook the fact that those students, interns, and residents have grown in an era of the expansive global interest in genetics post conclusion of the big human genome project in 2003[38]. Despite this seemingly higher knowledge level of the younger generation, we must emphasize here that academic institutions in Jordan still do not cover topics related to PG applications in their curricula. This indeed could largely explain the low overall knowledge scores among Jordanian students and physicians alike.

A previous study from Jordan by Jarrar in 2019 assessed the perception and knowledge of internist physicians about PG from various private and public Jordanian hospitals[39]. The study reported a generally good knowledge regarding the basic principles of PG, albeit still not widely practiced. It must be noted, however, that the author only included internist physicians in the study, and did not explore the perceptions of other medical and surgical disciplines, as well as medical students, interns, and residents, contrary to our study. Moreover, the report by Jarrar did not discuss issues related to future expectations and perceived barriers to PG application.

Several studies worldwide highlighted the overall positive attitude of healthcare professionals toward PG and its importance in improving the quality of health services they provided. These include studies from the USA[40], Canada[41], Kuwait[34], Qatar[29] , India[37], and Jordan[39]. Our results here reinforce such observations. Counterintuitive to our aforementioned findings on knowledge, specialists had a slightly stronger positive attitude towards PG application than residents (p=0.03), possibly because the latter fear that such tool might add an extra load on their job duties. Nonetheless, this finding encouragingly sheds light on the importance of PG in clinical practice from the point of view of the most senior professionals. Our results, as well as of others, of a low overall knowledge coupled with a strongly positive attitude about PG among physicians represent an urgent call for a quick goal-oriented educational strategy. Such strategy should comprehensively aim to integrate PG concepts into medical curricula, promote the culture of continuous medical education for practitioners, and introduce PG application into clinical practice.

On the other hand, the overall future expectations and practice score in our sample was remarkably high. The majority of respondents were interested in applying PG in their future practice, representing a promising outcome of our study. In spite of the statistically significant differences in future expectations of respondents depending on age and primary work settings, perhaps due to variability in sample sizes of these groups, the overall context remains bright.

The current study had the advent of gauging the perceived barriers to practice of PG testing in Jordan by clinicians and medical students. According to our survey, the major concern of clinicians was the expensive cost of PG tests coupled with a lack of insurance coverage, in agreement with several other studies published elsewhere[29,40]. Additionally, lack of approved clinical guidelines and the limited provider knowledge and awareness about PG were high among our respondents. Importantly, this finding emphasizes our belief that

our clinicians still struggle to interpret PG test results and would find it difficult counseling the patients about their consequences. Intriguingly, only a minority of our clinicians and medical students (39.6%) believed that their cultural and/or religious beliefs would affect the clinical practice of PG in a conservative community like North Jordan.

Our study manifests a few limitations. First, the response rate was fairly low. However, we assume that a higher response rate might have a more detrimental impact on the overall knowledge and attitude of participants. Second, generalizability of our results is of concern, as the sample was recruited solely from North Jordan, although national differences in knowledge, attitude, and practice of PG by geographic location have not been previously reported. Furthermore, we believe that this study presents a pilot assessment that has a potential on national aspects. Third, the scales utilized in the current study were collapsed into the minimum categories. Such approach is justified by the evidence showing that Arabs, similar to other non-European-American groups, are less likely to use middle response categories when presented a greater number of options[42,43].

In conclusion, physicians and medical students in Jordan have low overall knowledge, however strongly positive attitude and future expectations toward PG. High cost, lack of clinical guidelines and insurance coverage, and poor awareness are among the major barriers towards PG applications in Jordan. Our study supports the findings of several other studies worldwide to adopt PG and calls for urgent training and educational programs to enhance its practical practice.

Disclosures

The authors report no conflicts of interest.

Ethical Approval

Informed consent was obtained from all individual participants included in the study. The study design and procedure were approved by the Institutional Review Board at Jordan University of Science and Technology.

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Tables

Table 1: **Major characteristics of study participants (N = 424).**

Table 2: **Distribution of total knowledge, attitude, and future expectations and practice scores according to certain sociodemographic and professional variables.**

Table 3: **Frequency distribution of perceived barriers to practice of PG testing in Jordan.**

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