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Physicians' Knowledge and Perception of Gene Profiling in Malaysia

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***Abstract*—**Availability of different genetic tests after completion of Human Genome Project increases the physicians' responsibility to keep themselves update on the potential implementation of these genetic tests in their daily practice. However, due to numbers of barriers, still many of physicians are not either aware of these tests or are not willing to offer or refer their patients for genetic tests. This study was conducted an anonymous, cross-sectional, mailed-based survey to develop a primary data of Malaysian physicians' level of knowledge and perception of gene profiling. Questionnaire had 29 questions. Total scores on selected questions were used to assess the level of knowledge. The highest possible score was 11. Descriptive statistics, one way ANOVA and chi-squared test was used for statistical analysis. Sixty three completed questionnaires were returned by 27 general practitioners (GPs) and 36 medical specialists. Responders' age ranges from 24 to 55 years old (mean 30.2 ± 6.4). About 40% of the participants rated themselves as having poor level of knowledge in genetics in general whilst 60% believed that they have fair level of knowledge; however, almost half (46%) of the respondents felt that they were not knowledgeable about available genetic tests. A majority (94%) of the responders were not aware of any lab or company which is offering gene profiling services in Malaysia. Only 4% of participants were aware of using gene profiling for detection of dosage of some drugs. Respondents perceived greater utility of gene profiling for breast cancer (38%) compared to the colorectal familial cancer (3%). The score of knowledge ranged from 2 to 8 (mean 4.38 ± 1.67). Non- significant differences between score of knowledge of GPs and specialists were observed, with score of 4.19 and 4.58 respectively. There was no significant association between any demographic factors and level of knowledge. However, those who graduated between years 2001 to 2005 had higher level of knowledge. Overall, 83% of participants showed relatively high level of perception on value of gene profiling to detect patient's risk of disease. However, low perception was observed for both statements of using gene profiling for general population in order to alter their lifestyle (25%) as well as having the full sequence of a patient genome for the purpose of determining a patient's best match for treatment (18%). The lack of clinical guidelines, limited provider knowledge and awareness, lack of time and resources to educate patients, lack of evidence-based clinical information and cost of tests were the most barriers of ordering gene profiling mentioned by physicians. In conclusion Malaysian physicians who participate in this study had mediocre level of knowledge and awareness in gene profiling. The low exposure to the genetic questions and problems might be a key predictor of lack of awareness and knowledge on available genetic tests. Educational and training workshop might be useful in helping Malaysian physicians incorporate genetic profiling into practice for eligible patients.

***Keywords*—**Gene Profiling, Knowledge, Malaysia, Physician.

I. Introduction

THE Human Genome Project has been completed and it is expected that incorporation of genomic medicine into many aspects of medical practice will improved human health. The promising contributions of genomics to enhance human health has been driven by results from numerous studies which focus on different types of human cancer, the molecular basis of inherited diseases and DNA structural abnormalities [1]-[5]. Information from some of the genomic studies has already led to the development of new therapies [6]-[9]. Moreover, in some countries pharmacogenomic testing is regularly implemented before administration of certain medications [10]. However, new opportunities for genetic testing challenge health care providers with the problem of which test to be used for whom. According to numbers of studies, lack of knowledge of genetics and genetic tests amongst medical doctors is a worldwide problem [11]-[14].

In 2007, numbers of companies offer personalized-genome tests over the internet to predict susceptibility to common multifactorial diseases as well as drug responses (pharmacogenomics tests), based on polymorphisms data obtained from genome-wide association study [15]. This commercial and direct to consumer genetic tests and especially gene profiling creates large debates around value of these tests among physicians and publics. Then, it is expected that medical doctors should have a broad knowledge of available and approved tests and be able to counsel these tests options to patients. Evidently, general practitioners (GPs) remains at the frontline of medical care to see individuals at risk for, and affected by, multifactorial diseases such as CVD and diabetes [16]. In Malaysia, similar to many other countries, referrals to specialists are mostly advised by the GPs, on the other hand, they are as gatekeepers to specialist care. Considering the availability of different new diagnostic options using genetic tests as well as higher demands from the public, physicians are required to obtain a higher level of familiarity with these tests. Results from several studies have revealed the willingness of healthcare providers to include genetics in their daily practice; nonetheless they believe it is necessary to have additional education in genetics [17]-[20]. Struggling with different medical, social, and ethical questions associated with genetic counseling and testing may affect the physicians' choice who would like to refer their patients for

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these services. These questions are include the potential risks and benefits, accuracy, clinical validity and limitations of genetic tests; availability of effective medical interventions for patients with genetic predisposition risk, patient privacy, cost and insurance coverage. It is proposed that comprehensive education regarding the complexities of genetic tests using new technologies such as next generation sequencing should be provided for physicians whose patients may benefit most from genetic testing then they can provide suitable advices and medical care [21]. As a positive predictor, knowledge and awareness of availability of genetic tests increases the referral a patient to genetic counseling centers [22], [23]. It has been reported in other countries that rate of referral to genetic counseling has not been improved over the years for families having a child affected by a congenital syndrome [24]. Moreover, approximately 10% to 20% of the women did not refer for a genetic counseling before their pregnancy even they have had a known genetic risk factor, mainly because GPs were not aware of the potential risk factor [25].

Currently, in some countries physicians are suggesting genomic risk profiling to their patients [19], [26] but there is no comparable movement among Malaysian doctors. Then, the present study is aimed to evaluate the physicians' knowledge and perception of gene profiling in Malaysia. It is hoped that the results from this study will deliver more insight of educational and training needs of Malaysian physicians

II. Methodology

A. Participants

This research was conducted among randomly selected physicians working in various hospitals in Malaysia.

B. Questionnaire Development

A literature review was done to develop a questionnaire containing of 29 questions (using a Likert response and multiple choice responses) to encounter the objectives of this study. Some of the questions were adapted from previous publication [27]. This survey addresses demographic characteristics (5 questions), participants' training and experience with genetic testing; knowledge and perception on genetic testing for cancer and pharmacogenomics. A total of 11 questions were assessed the level of knowledge. Each correct answer was assigned 1 point. The overall scores attributed to gene profiling knowledge were calculated by summing individuals' correct answers to the knowledge questions that could range from 0 to 11, where a score of 0 means no correct answer and a score of 11 means that all the answers were correct. Accordingly, the gene profiling knowledge levels were recorded as follows: 9-11 points, very good; 6-8 points, good; 4-5 points, mediocre; 3points and below, poor. The survey was piloted with 10 general practitioners participating a master program in Kuala Lumpur. No modifications were made.

Ethical approval was obtained from the research and ethics committee in the Faculty of Medicine and Health Science, UCSI University

C. Statistical Analysis

The results from each questionnaire were manually entered in the SPSS, version 21. The differences in the frequency distribution were tested by Chi-squared tests. The differences between each group of demographic factors were measured by using analyses of variance and means. $P < 0.05$ was considered statistically significant.

II. Results

The overall survey had a response rate of 53% (63/120). Responders' age range from 24 to 55 years old (mean 30.2 ± 6.4) majority of them (71%) in age group 25-35 years old. Overall 27 GPs and 36 specialists participated in this study. Table I shows the characteristics as well as the mean score of the correct answers to knowledge questions for each group.

TABLE I
Characteristics of Participants

Characteristic	Number	Mean Score of Knowledge
Age group		
Less than 25	9	4.44 ± 0.53 **
25-35	45	4.53 ± 0.28 **
36-45	5	4.25 ± 1.31 **
46-55	4	4.50 ± 1.32 **
Gender		
Male	26	4.38 ± 0.3 **
Female	37	4.54 ± 0.36 **
Profession		
General Practitioner	27	4.31 ± 0.3 **
Specialist	36	4.64 ± 0.35 **
Place of Graduation		
Asian Countries	58	4.54 ± 0.26 **
Non Asia countries	5	4.00 ± 0.45 **
Year in Practice from		
before 1990	2	2.50± 1.5 *
1991-1995	2	2.0± 0.5 *
1996-2000	2	2.0± 0 *
2001-2005	4	6.0± 1.01 ***
2006-2010	35	4.51± 0.31 **
2011 onward	18	4.41± 0.40 **

* Group with poor level of knowledge (score less than 3)
** Group with mediocre level of knowledge (score less than 4-5)
*** Group with good level of knowledge (score 6-8)

In the self-assessment of knowledge, about 40% of the participants rated themselves as having a poor level of knowledge in genetics in general whilst 60% believed that they have fair level of knowledge. Almost half (46%) of the respondents felt that they were not aware of available genetic tests. Only 4% of participants were aware of using gene profiling for detection of dosage of drugs. There was only one participant (1.6%) who has been attended an elective genetic course. Among all the participants, 4 individuals (6%) rated themselves of being qualified to recommend gene profiling. A majority (94%) of the responders were not aware of any lab or company which is offering gene profiling services in Malaysia. Four individuals (6%) knew that there are companies in Malaysia who offer gene profiling services however, only one of these physicians mentioned that the

companies approached him to offer the gene profiling services to his patients.

When results from the self-assessment of knowledge was analyzed according to the medical specialists, a half of specialist rate themselves as having poor level of knowledge in genetics in general whilst it was only 27% of the general practitioners (GP) who had rated themselves as having poor level of knowledge (Table II). However, when the responders asked whether they think they are qualified to recommend the gene profiling to their patients, only 8% of specialist and 4% of GPs felt they are qualified to recommend gene profiling (Table II).

TABLE II
QUESTIONS FOR SELF-ASSESSMENT OF KNOWLEDGE GENE PROFILING

Question	GP (%)	Specialist (%)
Rate your knowledge in genetics in general		
Poor	8 (27%)	17 (50%)
Fair	19 (73%)	19 (50%)
Estimate your knowledge in available gene profiling for daily practice	12 (42%)	17 (54%)
Not Knowledgeable	15 (58%)	19 (46%)
Somewhat Knowledgeable		
Being qualified to recommend gene profiling		
Yes	1 (4%)	3 (8%)
No	14 (52%)	22 (67%)
Not Sure	12 (44%)	11 (25%)

Overall, both GPs and specialists showed relatively high level of perception (83%) on value of gene profiling to detect patient's risk of disease. However, low perception was observed for both statements of using gene profiling for general population in order to alter their lifestyle (25%) as well as having the full sequence of a patient genome for the purpose of determining a patient's best match for treatment (18%) (Table III).

The score of knowledge ranged from 2 to 8 (mean 4.38± 1.67). There was no significant association between any demographic factors and level of knowledge (Table I).

TABLE III
QUESTIONS ON PERCEPTION OF GENE PROFILING

Question	GP (%)	Specialist (%)
Gene profiling can be recommended to the general population in order to intervene their lifestyle		
Yes	8 (27%)	8 (21%)
No	16 (61%)	24 (75%)
Not Sure	3 (12%)	4 (4%)
Opinion on value of gene profiling to detect patient's risk of disease		
Not Valuable	1 (4%)	3 (4%)
Somewhat valuable	16 (61%)	22 (50%)
Very Valuable	10 (35%)	11 (46%)
Having the full sequence of a patient genome is costly but it can help for the purpose of determining a patient's best match for treatment?		
Yes	7 (23%)	4 (17%)
No	16 (65%)	26 (79%)
Not Sure	4 (12)	6 (4%)

However, those who graduated between years 2001 to 2005 had higher level of knowledge compared to the graduates from other years. There were no differences between the mean of total score for knowledge between those who rate themselves having poor or fair level of knowledge.

Table IV shows the details of participants' views regarding the value of genetic testing for particular diseases by self-perceived knowledge of gene profiling. Minority of participants (6%) believed that genetic tests for inherited cancer susceptibility have too many false positive, false negative, or ambiguous results. Respondents perceived greater utility of gene profiling for breast cancer (38%) compared to the colorectal familial cancer (3%).

TABLE IV
QUESTIONS FOR SELF-PERCEIVED KNOWLEDGE OF GENETIC TESTING

Question	Yes	No	Not Sure
Genetic tests for inherited cancer susceptibility have too many false positive, false negative, or ambiguous results.	4 (6%)	40 (64%)	19 (30%)
Offering gene profiling is a reasonable course of action for predicting each of the following diseases:			
Heart disease	10 (16%)	38 (60%)	15 (24%)
Familial Colon Cancer	2 (3%)	29 (46%)	32 (51)
Breast cancer	24 (38%)	34 (54%)	5 (8%)
Diabetes	19 (30%)	34 (54%)	10 (16%)
Hemochromatosis	18 (29%)	33 (52%)	12 (19%)
Alzheimer	11 (18%)	33 (52%)	19 (30%)

One of the questions asked how physicians would want to be educated about gene profiling. The most given answers were medical school course(s) (41%) followed by continuing medical education (CME) (37%),

The most common barriers to implement the gene profiling in daily practice were reported to be lack of clinical guidelines, limited knowledge and awareness amongst physicians, difficulties to educate patients, lack of evidence-based clinical practice and cost of tests were the most barriers of ordering gene profiling mentioned by physicians.

IV. DISCUSSION

Physicians in this study were not well informed about gene profiling neither in general nor in cancer diagnosis and pharmacogenomics. In this study, general practitioners (GPs) shown more confident on their knowledge in genetics in general compared to the specialists. This observation challenges the evidence in the literature which suggest for a number of diseases specialists have higher level of knowledge compared with GPs with regards to patterns of treatment and care as well as outcomes. It has been reported that specialists and GPs have generally different response to adopt new treatments and medical applications [28]. Since the role of GPs in primary care in early diagnosis and treatment of diseases has been emphasis [29], our results has a promising massage regarding how GPs in Malaysia maybe integrate the gene profiling in their daily practice if the proper training opportunities will be provided.

The higher score of knowledge which observed among graduates between years 2001 to 2005 may be explained by the fact that a working draft of human genome was announced in 2000 over the completion of human genome project whilst a complete version was published in 2003. More likely there were more news and awareness during these specific years

which consequently might be increased the medical students' attention toward genetics.

None of the study participants has ordered any genetic tests for their patents. It is far from the current practice in some countries such as USA. Shields et al. [26] have reported that 60% of physicians in primary care setting in USA have requested a genetic test for their patients whilst 74% of them have referred a patient for a genetic test and 17% to a clinical trial. It has been reported that physicians' familiarity with the gene profiling is a key predictor of ordering a genetic tests. Our findings demonstrate that respondents were not familiar with the available genetic tests and this can explain their ordering behavior. Another study done in Swiss demonstrated that the primary care physicians want to play a central role in the management of these families, but lack the knowledge to do so efficiently [30].

Baars et al. [11] reported a higher knowledge score in genetic testing among physicians who graduated more recently, which is in line with results in the US, however in our study there was no differences between the recently or previously graduates. Lack of knowledge in almost all the participants regarding pharmacogenomics was a surprise. There are numbers of studies which have addressed the advantages of pharmacogenetics interventions in healthcare [31]-[33]. In FDA webpage there are a list of medicine which the pharmacogenomics tests are been recommended but our participants were not aware of this opportunity.

Participants showed uncertainties about readiness of genetic technologies to be considered as important elements of their practices. Inadequate documents and evident on clinical validity and utility were reported as leading cause of participants' concerns before implementing predictive gene profiling. They expressed their interest to adopt new genetic tests, if these barriers were to be eliminated, especially when patients request the available optional tests,

V. Conclusion

The results from this study might be considered as baseline estimates on extent of integration of genetic testing and referral into clinical practice among physicians in Malaysia. The participants had low exposure to the genetic questions and problems and it might be a key predictor of lack of awareness and knowledge on genetic tests. This finding is similar to the results of other studies. Subsequently, results showed that doctors in Malaysia, both GPs and specialist, are deficient in knowledge in available gene profiling tests. Educational and informative course may improve acceptance of genomic risk profiling among Malaysian physicians especially in cancer genetics and pharmacogenomics. Particularly, educational programs sponsored by a genetic/genomic testing company may enhance the physicians' knowledge of available genetic tests with sufficient clinical validity and utility.

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