THE ETHICS OF PERSONALIZED MEDICINE

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The early XXI century was marked with entry into the market of a great deal of medicinal preparations with a totally new molecular-oriented mechanism of action. These results could only be made possible through achievements in molecular and cellular biology and completion of the Human Genome Project, in particular. Many pathogenic mechanisms of different illnesses, including oncological and autoimmune ones, were deciphered. The data stimulated the search for totally innovative therapy methods targeting at the key links of the abnormal process pathogenetic chain, collectively known as 'targeted therapy'. The issues of personalized medicine, including the ethics, are considered through the study of the Coriell Institute.

Key words: personalized medicine, genetics, genomics, targeted therapy

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ПЕРСОНАЛИЗИРОВАННАЯ МЕДИЦИНА С ТОЧКИ ЗРЕНИЯ МЕДИЦИНСКОЙ ЭТИКИ

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Начало XXI века ознаменовалось выходом на мировой фармацевтический рынок большого количества лекарственных препаратов с абсолютно новым молекулярно-ориентированным механизмом действия, что стало возможным благодаря достижениям в области молекулярной и клеточной биологии, в частности, завершению проекта «Геном человека». При этом удалось расшифровать многие механизмы патогенеза различных заболеваний, включая онкологические и аутоиммунные. Появление этих данных явилось стимулом для поиска принципиально новых методов терапии, точечно воздействующих на ключевые звенья патогенетической цепи патологического процесса, получивших в связи с этим общее название «таргетная терапия». На примере исследования института Coriell рассмотрены проблемы персонализированной медицины, в том числе в аспекте медицинской этики.

Ключевые слова: персонализированная медицина, генетика, геномика, таргетная терапия

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Personalized medicine is a new paradigm in biomedicine. Its successful implementation requires integration of unprecedented information volume and various communities, not only professional ones. The ability to collect, analyze, exchange and integrate an enormous amount of biological and clinical data on a real time basis is a prerequisite of personalized medicine.

Biomedicine is a complex system with key interrelations between the sectors. The objective of personalized medicine is transformation of this system, that's why it's necessary to acknowledge and accept its complexity. Key possibilities to create a self-sustained subsystem of personalized medicine arise owing to understanding the flows of resources and data within a larger system of clinical medicine.

Threatening complexity of the personalized medicine subsystem makes the use of information technologies critically important. However, information technologies as part of the biomedical community are being developed slowly, and they rarely connect laboratories even within the same institution, much less those at various institutions.

Thus, to solve complex issues of oncological diseases and eliminate similar gaps in the research process, the biomedical society of the XXI century requires implementation of inter-operability, i. e., access to integrated instruments to collect, analyze and exchange data in standardized formats. The inter-operability is a tool that unites all scientists, clinicians, patients and other participants to ensure fast exchange of the standardized information.

Personalized medicine needs data exchange. This should be implemented through the best practices in the sphere of information technologies. Information technology applications are randomly divided into approaches used to connect data and the ones to connect people.

The key advantage of personalized medicine complete subsystem conceptualization is an ability to turn biomedicine into the educational system. More precisely, a synergistic union of studies, provision of medical aid, quality assessment, measurement of effectiveness and safety of the used medicinal preparations is possible, while covering the entire life cycle of biomedicine.

Personalized medicine means that prognoses, predictions, diagnostics and therapy are adapted to certain individuals considering their biological features. Then it can be warranted that a certain individual will undergo certain activities at a certain time. For this, not only medical technologies, but also a better information infrastructure, improved integration of clinical and research efforts, constant innovations in medical education and, finally, deep relation with a patient who becomes a partner in obtaining the medical aid need to be developed.

ONCOLOGY AS A PIONEER OF PERSONALIZED MEDICINE

Researchers of oncological diseases were at the leading edge of personalized medicine revolution and many first-generation medications (tamoxifen, imatinib, etc.) of personalized medicine

were developed for their treatment. The reasons for this phenomenon were as follows.

1. Oncopathology is a complex set of diseases. Approaches to their examination with the help of molecular medicine occurred before the Human Genome Project. At the end of the XX century, it was known that oncopathology was caused by genetic changes, both inherited, and acquired, leading to abnormal cellular proliferation, slow induction of apoptosis, metabolism activation, neoangiogenesis and metastasis.
2. Oncopathology is a serious and frequently deadly disease characterized by very low effectiveness of therapeutic medications. As selection of the most effective treatment can be an urgent decision associated with life or death, approaches to personalized medicine as compared with the time-consuming trial-and-error method have obvious advantages.
3. Side effects of anti-tumor therapeutic agents are rather unpleasant, they often mutilate a patient and are potentially lethal. That's why it is even more important to select an optimal therapy at the first visit to avoid double negative unfavorable effects due to useless treatment.

For instance, the National Cancer Institute (NCI) has a unique set of administrative platforms that embrace the entire life cycle of biomedicine development and create a unique environment that can serve as a prototype of the personalized medicine paradigm. For 50 years the NCI has been supporting complex oncological centers that combine scientific research, provision of medical aid and prevention. There exist over 60 similar centers distributed over the country and located in the most prestigious research and therapeutic institutions of the USA. The NCI has over 50 Specialized Programs of Research Excellence (SPOREs) that support translational studies and 10 Cooperative Group programs that conduct multi-institutional clinical trials. As far as the medical aid goes, the NCI has launched the Program of Public Oncological Centers (NCCCP) with 16 objects and 20 million people.

In 2003, the NCI decided to integrate unprecedented information technologies into the biomedical society due to three factors such as the growing clinical and economic burden of oncopathology, transformation of trials, acting as a catalyst for molecular revolution, and numerous technologies of genomics that generate enormous amount of data and accept that 'the essential unity' of trials and clinical aid can improve the outcomes in all types of oncopathology, just like it was done with pediatric oncology. As the first step in creating the infrastructure of informatics that would enable medicine personalization, the NCI officially launched the pilot caBIG® (cancer Biomedical Informatics Grid) initiative in 2004. Its primary objective was to develop the possibilities that would correspond to certain requirements of the NCI oncological center society (more detailed data about the history of caBIG® see in the caBIG® pilot phase report at http://cabig.cancer.gov/resources/report.asp.)

Though the revolution in molecular biology occurred in the late XX-early XXI centuries, the target concept was formulated by Paul Ehrlich, a German scientist, in the beginning of the last century. He believed that a target is an enzyme (or any other biological molecule, organelle, physiological feature, etc.) present in a pathogenic microorganism, which is being essential for vitality of the latter, but absent in a patient's body. Thus, the medications specifically inhibiting target molecules should have an extremely wide therapeutic index. For instance, they can display high antibacterial activity with the least number of adverse effects. Traditional antimicrobial agents such as antibiotics, antimycotics, antivirals agents, etc., are based on a similar principle. Anti-tumor agents should have equivalent properties, but differences between mutated and initial cells are more sophisticated and complicated as compared with differences between bacteria and a human being [1]. A new generation of medications (the so-called targeted antitumor agents) were developed in the late XX century only due to rapidly progressing molecular oncology [2].

ISSUES ASSOCIATED WITH IMPLEMENTATION OF PERSONALIZED MEDICINE

Personalized medicine uses the underlying genomic/genetic information about a patient to predict the risk of diseases, diagnose the existing pathology, prevent adverse reactions to medicinal agents and adapt to treatment (fig. 1) [3–5].

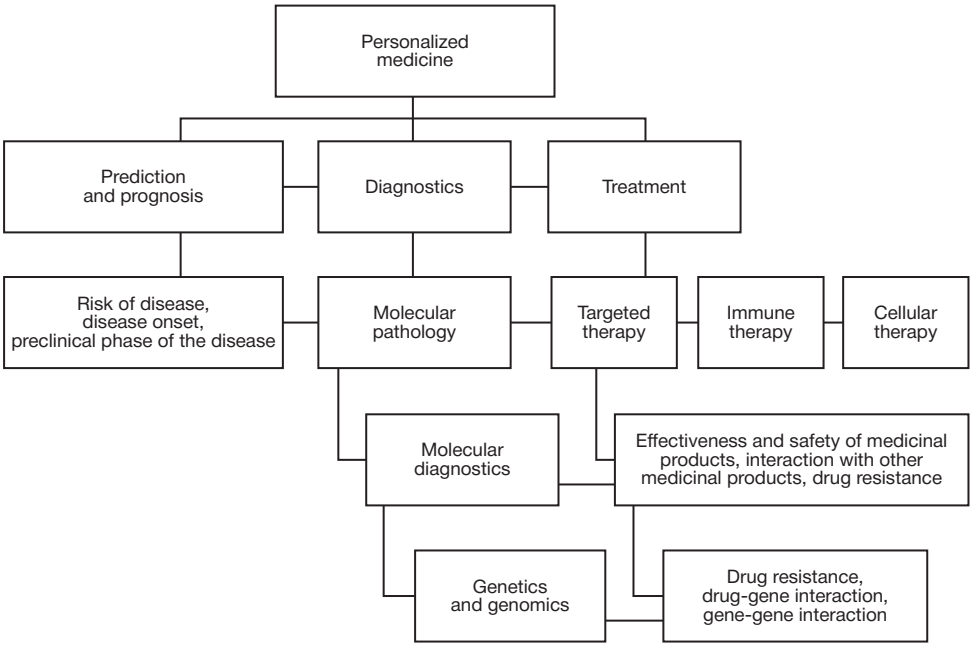

Fig. 1. Scheme of the structure of personalized medicine

Successful implementation of personalized medicine depends on several factors. First, there exists an acute need in teaching medical professionals detailed genetics [6–9]. The volume of genetics commonly taught at medical universities is limited. It deals with monogenic disturbances and chromosomal abnormalities, whereas students know nothing about complex genetics.

Second, integration of personalized medicine requires state support and regulatory surveillance [10–12], and public discussion of ethical issues [13, 14]. Third, systems of medical documentation need to be structured in such a way as to ensure that they accept genetic data and integrate them into the existing medical record of a patient. Then they will be used while taking clinical decisions.

Additional issues for evidence-based studies of personalized medicine effectiveness include the need to form large cohorts and collect longitudinal data for the database used to calculate treatment effects and estimate potential expenses and benefits. The cohort must be rather large to consider as follows:

1) genetic variations with low incidence (1–2%),
2) influence of a gene on the environment;
3) gene-gene interrelation; 4) last observation carried forward.

Large cohort studies also come across the issues of consent and confidentiality [15]. Moreover, genetic studies in larger cohorts require significant infrastructure of biobanking, genotyping and information technologies [16].

Importance of biobanking

Biobanking includes collection, characterization, storage and distribution of valuable biomaterials and associated research data. Biobanking is used to create and support bioreservoirs as national and international resources to study human disorders and ageing. Regular expansion of data management systems is necessary, including web-catalogue of biomaterials and related data. That's how there will be correspondence with the changing business and scientific requirements.

The possibilities of biobanking include significant management of phenotypic data using the standardized phenotypic language and collection of longitudinal data for a set of diseases [17, 18]. Moreover, cooperation with several regional healthcare systems is possible. Their rapid transition to complex systems of electronic medical records is possible. This will allow active completion of tasks associated with implementation of genomics into clinical practice.

SEARCHING THE WAYS OF DEALING WITH PROBLEMS OF PERSONALIZED MEDICINE

The Human Genome Project [19], SNP Consortium [20] and HapMap Project [21] laid the foundation for the next generation of efforts regarding genetic mapping of complex diseases and quantitative trait loci (QTLs) [22], which can be preclinical indicators of a potential disease. To make the data useful for health and quality of life improvement, it is necessary to create a mechanism of exchanging data about genetic variations associated with complex diseases, people and suppliers of medical services, and conduct scientific-based trials to estimate the results of the data obtaining and usage.

The Coriell Personalized Medicine Collaborative (CPMC) is a study that utilizes a scientifically substantiated approach to determine the value of using personal genomic data to control health and take clinical decisions.

The CPMC objective is to form a cohort with extensive genotypic and phenotypic data that can be used to find genetic variations influencing toxicity and effectiveness of medications and detect currently unknown gene variations that increase the risk of oncopathology and other severe diseases.

The study involves doctors, scientists, ethicians, genetic consultants, voluntary study participants and experts in information technologies, with the common task of better understanding of the effect of personalized or genome-informed medicine and ensuring its ethical, legal and domestic implementation. By the end of 2009, 10,000 people participated in this study, with 100,000 of participants being an ultimate purpose.

The global purpose of the CPMC is to become a model of ethical, legal and responsible implementation of personalized genome-based medicine. The CPMC study provides the dynamic connection between Coriell and study participants via the protected web-portal.

Web interviews are used to estimate health and personal data about genetic variations obtained during the study. Moreover, participants can share the data with medical professionals via this portal. The CPMC is currently funded from voluntary donations and institutional support with no costs for study participants.

When the informed consent is obtained, participants are requested to provide two ml of saliva for genome profiling using a microchip platform (Affymetrix 6.0 Genechip, Affymetrix, Santa Clara, CA) and target SNP profiling using a bead-based platform (Illumina BeadXpress, Illumina, San Diego, CA). The external group of experts (Informed Cohort Observation Board (ICOB)) meets at least twice a year to consider genetic variations provided by Coriell as health risk options.

Only genetic variations associated with health conditions which are considered potentially suitable for medical actions (when the risk can be reduced and the variations with a significant reproduced association) are later returned to participants via the protected web portal.

Participants can provide access to the doctor (doctors) to review the results and can request a free discussion of the results with the CPMC genetic consultant. Various results are estimated through web interviews where participants assess their own actions, actions of their doctors and their health conditions. The participants are asked to update data regarding health, family and way of life, because that is how longitudinal data are created. Thus, there exist several dynamic aspects of the CPMC including constant analysis of associative studies to reveal genetic variations and submit them to the regulatory authority (ICOB), constant examination of the obtained results and annual longitudinal collection of participants' medical records.

INVOLVEMENT OF HOSPITAL PARTNERS AND MEDICAL PROFESSIONALS

As far as the task of genomic data integration into medical practice goes, education of medical professionals, especially doctors and nurses, will probably be a restrictive step. The Coriell Institute is aware that involvement of clinicians and other medical professionals is important to develop successful integration strategies of complex genetic data into the modern medical paradigm. The Institute does the same by including them into the CPMC as coauthors and participants. Moreover, the prevalence of oncopathology in the society, and the huge potential of influence of personalized medicine on research and treatment of various types of cancer are highly estimated. That is why Coriell established cooperation with adjacent medical institutions to conduct the CPMC study. The Coriell Institute encourages participation of medical professionals and

employees of medical centers in the research. These relations activate the study and offer opportunities to teach medical professionals genomics.

One of the educational strategies of medical professionals will include seminars conducted by Coriell scientists and doctors from hospitals in partnership. The seminars are devoted to diseases included into the CPMC, and correspond to the requirements of continuous medical education (CME) enabling access to CME credits.

Trying to make education more affordable for medical professionals, Coriell company can provide access to seminars in genomic medicine via webcasts over the Internet.

Implementation of genomic medicine requires bilateral exchange, where scientists will teach medical professionals, and vice versa. The exchange will include traditional communication in addition to exchange with medical and genetic data (as electronic medical records and a great number of genetic testing results respectively). Coriell expects that deep involvement of several hospitals into the CPMC will be a catalyst for this dialogue. Moreover, it is suggested that as soon as the CPMC participants will invite medical professionals to learn about their personal genetic results, Coriell will have an involved and accessible population of medical professionals, among whom they can conduct focus-group interviews regarding the use of genomic information while providing medical service.

ENROLLMENT OF PARTICIPANTS INTO THE CPMC STUDY

People are enrolled in the CPMC study mainly during the informed consent sessions conducted at the Coriell Institution, hospitals in partnership and other public establishments. The principal researcher of CPMC or CPMC scientist discusses the study results, possible risks, content of the informed consent document and gives the participant a possibility to ask questions. When the informed consent form is signed, new participants are offered to give a small sample of saliva.

Requirements to participants are as follows: they must be over the age of 18, have a valid E-mail address and readiness to participate in interviews for several years. The participants can take a decision (during registration or at any time after that via the protected web portal) to present their unidentified genomic data about variations and case history to the scientific society to conduct associative studies. The CPMC study is free for participants.

ONCOLOGICAL DIRECTION OF THE CPMC

As Coriell is a partner of medical centers, including Fox Chase oncological center, it can conduct a study in addition to the abovementioned health direction. The first 10,000 participants involve 2,500 patients with breast cancer and 2,500 patients with prostatic cancer. There is some evidence that the primary risk of cancer strongly depends on genetic variations, and that in oncological patients, reaction to chemotherapeutical agents, medication associated side effects and clinical outcomes depend on genetic peculiarities of the patient.

Thus, formation of a large cohort of patients with breast and prostatic cancer, extensive phenotypic data from the national registries of these types of cancer and genomic/genetic data will allow researchers to examine the role of genetic variations at pharmacogenomic and clinical endpoints. The wide scientific society will get access to the unidentified data provided to the CPMC by participants via the database of genotype and phenotype (dbGaP) of the National Center of Biotechnological Information.

THE REGULATING AUTHORITY: INFORMED COHORT OBSERVATION BOARD

The Informed Cohort Observation Board (ICOB) estimates medical feasibility of health conditions and proof of potential medical feasibility of a genetic risk variation regarding this health (disease) condition. The principal condition to consider genetic variations is validity of association studies published in the literature. They demonstrate a significant relation between genetic variations and certain abnormal conditions. Thus, the ICOB determines which personal data about genetic variations will be returned to the study participants.

Approval is provided when knowing the participant's status regarding a certain genetic variation will influence the course of treatment assigned by a medical professional or will enable to provide an advice about health or way of life which promotes risk reduction. By using perspective web interviews, the CPMC study will help to determine whether the use of data about the variation reduces the risk.

The external advisory board includes recognized scientists, medical professionals, specialist in ethics and a pastor of a parish. The Board concept was offered by D-r Kohane et al. [23]. The approach is a model of the national system estimating genome-informed medicine.

The CPMC scientists study medical and scientific literature to reveal the variations of candidate genes and submit brief reports to the ICOB. The ICOB reviews every report and votes for approval, disapproval or request of additional data for every variation and condition. The factors that need to be considered include as follows:

- recommendations of the Food and Drug Administration of the USA (FDA), centers for disease control (CDC), national healthcare institutions, national associations of medical specialties or other government consultation bodies;
- severity of a disease, condition or potential unfavorable reaction to a medication;
- number, scope and quality of research that demonstrate statistically significant relation between the gene type and the disease. Meta-analyses (if any) are considered as well;
- the size of an effect of a certain genetic variation;
- risks and advantages of clinical interventions or interventions associated with the way of life to reduce or decrease the risk;
- data elements to measure results.

The ICOB's assertion means that the relation between the genetic variation and health condition was confirmed and the condition is considered as potentially suitable for medical application. The assertion does not require robust evidence stating that the variation is useful for influencing the treatment outcomes. The CPMC task is to submit the outcomes in order to determine the usefulness of every genetic variation.

The ICOB meets at least twice a year. The frequency allows to integrate the results of the reviewed association studies, find new associations and confirm the previous outcomes.

It is quite likely that the CPMC will later ask the ICOB to consider both previously declined variations with new scientific proof, and previously declined conditions of health in relation to which prevention or treatment possibilities changed the potential ability to act. The ICOB decisions are taken by the majority of votes. In a group, discussions are held in a closed regimen. It is warranted that scientific issues are discussed in the objective, critical and unburdensome setting. However, all discussion outcomes are manifested via the web portal.

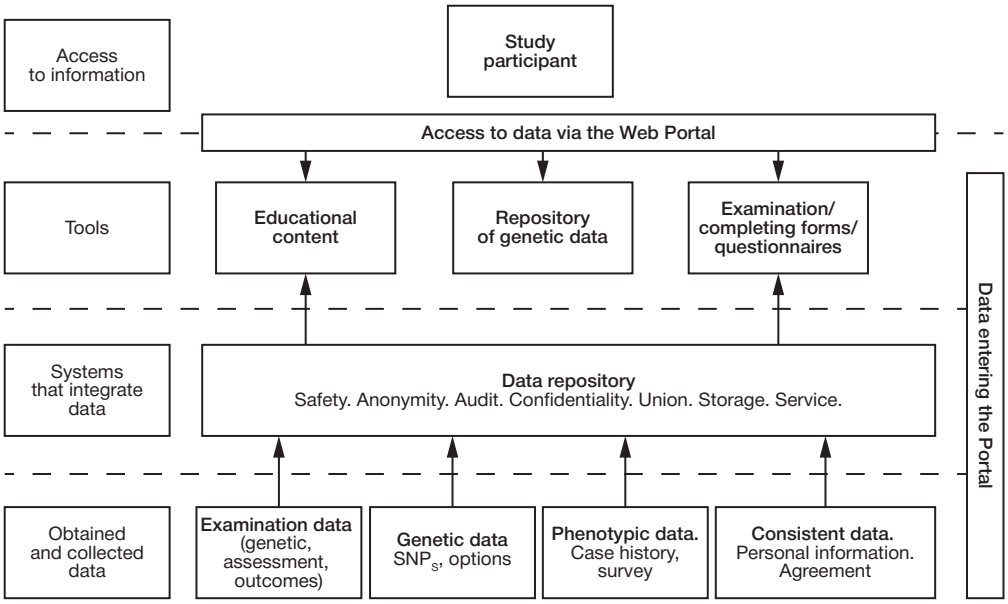

Fig. 2. Architecture of the CPMC research web portal

DYNAMIC INVOLVEMENT OF PARTICIPANTS: THE RESULTS ARE VIEWED THROUGH THE PROTECTED WEB PORTAL

The CPMC web portal is a web site with several functions. It allows to:

1) collect data using online interviews,
2) report the results of genetic variations,
3) educate participants and medical professionals,
4) safely share personal information about genetic variations with medical professionals,
5) request access to data from scientists via the Internet;
6) request genetic counselling from participants via the Internet.

It is a public site with a portal that enters the protected server. In the protected part of the site, participants can configure the CPMC account with a password, change contact data (E-mail address), update the consent options (consent to present their unidentified data for genome wide association studies (GWAS)) and review data about personal genetic variations as they become available.

Moreover, the CPMC web portal has a significant number of materials regarding genetic education. These materials are written for two different audiences such as non-professionals and medical professionals though any person can get access to more advanced educational materials. Educational pages include data about basic genetics and such important scientific events as the Human Genome Project and HapMap Project. Educational materials about inheritance, types of oncopathology, multifactorial nature of complex diseases, the term of 'risk' and interpretation of disease risk estimation, and the reasons for which the research is possible today only.

Every time participants visit the web portal, they are involved in the process anew. They need to review the results of every genetic variation on their own. It warrants that the results are controlled by the participant, and that the participants are not informed about the results they are not actively searching for. The persons who decided to review the CPMC results will see a short educational video where a genetic consultant will give preliminary recommendations about this issue before revising data about the personal genetic variant. The CPMC will encourage participants to invite their treating physicians to see the results. The participants can provide access to their results using their accounts on the CPMC web portal.

Moreover, the site provides actual data about the possibilities for participants such as the study related free genetic consultations, educational forums and additional interviews. The CPMC can display data about other researches participated by the subjects. The scheme of information system architecture is presented in figure. 2.

Personal information is decoded and stored separately from the genotype and medical information. This is how data confidentiality is preserved. Two factor safety is used for dynamic creation of web pages, while participants are viewing their personal data.

REALISTIC RISKS: EXPLAINING THE VALUE OF RISK INCREASE

The CPMC tries to report the realistic risks related to genetic associations using the format which is easily comprehended by non-specialists. All presented results will show the known population risk of a disease (specific for race/gender/age-related groups, if any) and corrected risk based on the genotype of a genetic variation.

Though in some cases a certain genotype can significantly increase the risk, it is expected that the majority of genetic variations associated with complex (multifactorial) diseases will result in insufficient increase of the risk. Until the algorithms for the union of risks associated with more than one genetic variation are verified, each of them will be presented separately. All reports about the results include references to basic literature sources.

To make participants and medical professionals comprehend the risks associated with genetic variations included into the CPMC results, an educational section 'Comprehension of chances' was created on a web portal. In this section written both for non-professionals and medical workers, a concept is described, in accordance with which the risk of complex diseases is dynamic and includes an interrelation between genes and environment.

Moreover, a genetic investment in a complex disease is discussed, the likelihood that the genetic risk of a complex disease is influenced by dozens of separate genes, but not the

only and currently reported variation, is considered, and the results are reviewed. It is also explained that considering the current level of knowledge, family history is probably the more significant factor of risk of the majority of complex diseases as compared with one genetic variation.

COMPREHENDING THE RESULTS: GENETIC COUNSELLING

In the epoch of genomics and personalized medicine, genetic counselling requires a new approach to one gene-associated violations, which should be different from traditional counselling [24]. Coriell employs certified genetic consultants involved in the CPMC study who are ready to provide genetic counselling via E-mail, by phone or during personal consultations in the office and on educational forums which are open for the CMPC participants. Medical professionals whose patients participate in the study can also request access to genetic counselors of the CPMC to discuss the study and data about genetic variations. Genetic counselors will register all meetings with the CPMC participants using the password-protected database accessed by the CPMC genetic counselors only. Owing to the data base, genetic counselors will have an easy access to the history of contacts between them and participants. Then the counselors can trace the amount of time and type of conducted consultations, and collect statistical data by types of diseases and variations for which consultations are requested. The tracing system will also enable to find common areas of concern, which can be used in future to educate both common citizens, and medical professionals.

MEDICAL HISTORY, FAMILY HISTORY AND WAY OF LIFE QUESTIONNAIRES

Participants must fill in extensive medical history, family history and way of life online questionnaires after the personal account was created in the CPMC. The questionnaires should be filled in before the genetic results are reviewed. The participants will be offered to update medical history, family history and way of life data one year after the data were introduced and then every twelve months. The data will be used for two purposes: 1) combined with genotype data to calculate the personalized risk, when possible, 2) combined with genotype data in GWAS studies to detect additional genetic variations that promote development of complex diseases and/or metabolism of medications (for those participants who permitted the use of their unidentified data for association studies).

Coriell accepts the importance of CPMC data in GWAS studies. It created a mechanism (via the participant's consent form) that enabled participants to inform about their will to submit unidentified data to researchers (both to non-commercial, and commercial organizations). Thus, unidentified CPMC data will be provided to all certified researchers via the NCBI dbGaP web portal.

The model is to conduct interviews via the web portal enabling a crosscheck of data through various questionnaires. The longitudinal nature of this project, constant publication of genetic variation results and request of annual interview data update allows to collect data which are commonly difficult to obtain such as the regimen of nutrition and physical load over time and environmental influence as far as they arise.

LONGITUDINAL DATA COLLECTION: ELECTRONIC MEDICAL RECORDS

The subjects can select the last medical records from their supplier of primary medical aid in printed or electronic form if they are located in the system of electronic medical records (EMR) of the hospital in partnership. The updated medical records will be requested annually to ensure longitudinal data collection. The datasets will be traced to detect changes in health values associated with the diseases for which the CPMC submitted data about genetic variations. Medical records will be compared with self-reports of patients about their case histories.

The CPMC employees will decode part of information from the medical record and place it into the personally controlled medical record for every subject. All systems of information technologies by Coriell will ensure compliance with the standards of operational compatibility (HL7) and definitions of medical data such as SNOMED and LOINC.

CONFIDENTIALITY AND SAFETY OF PARTICIPANTS

Coriell has a number of provisions to support the integrity, confidentiality and safety of data and information systems at its disposal. At Coriell, the policies of safety warranting protection of all data from unauthorized access are valid; audit logs, procedures of backup and error checking are supported. This is how the CPMC data are made accurate and protected. Data safety is a balanced combination of actions by the authority and personnel, operational activity and measures of technological control.

The infrastructure of the CPMC information technologies includes three highly-integrated technological levels:

1) web portal,
2) system of managing laboratory information to control disposable material, phenotypic data and processes,
3) protected hardware infrastructure containing servers of web applications, servers of databases, storage arrays and network security devices. Personal identifying data is decoded and stored in a data base separate from a genotype and medical data. Subjects shall have to enter the protected web portal using the bar code identifier, user name and secure password.

ACCESSIBILITY OF CPMC DATA FOR RESEARCHERS AROUND THE GLOBE

The CPMC team and the National Institute of Human Genome Research discussed the strategy of displaying unidentified data of the CPMC participants who decided to share their data with scientists to conducts research via the dbGaP web portal. The Coriell Institute endeavors to provide a wide access to the valuable set of data. The Institute has been placing the data on dbGaP portal for a long time so that they could be used by certified scientists. It also participated in return of genotypic data based on samples of Framingham Heart Study from the depositary of the National Institute of Neurological Diseases and Stroke, and National Institute of Common Medical Sciences at Coriell.

OUTCOME STUDIES

The subsequent studies of actions of the CPMC subjects and medical professionals and participants' health outcomes form the basis of this evidence-based study. Thorough initial estimation of medical history, family history and way of life is carried out prior to announcing the results of personal genetic variations. Moreover, subjects can check the initial knowledge of genetics.

In respective scaling, CPMC-collected data will be used to estimate whether healthcare expenses are increased due to implementation of genomic medicine by using the objective

criteria such as a number of visits for treatment, prescribed analyses, hospitalization-based data and prescription for medications. The values of medical practice based on physician opinions and recommended practices will be balanced by way of studying the choice made by the participants dealing with different options of medical service. Coriell will develop these values in cooperation with hospital partners and such companies as the Center for Technology Assessment to ensure monitoring of the respective elements of clinical data.

CONCLUSION

The CPMC is a new model of translational medicine, evidence-based study, intended to determine which elements of personal genetic data are valued while taking clinical decisions and obtaining results of health care. The web portal containing medical records and genomic data is highly dynamic due to constant update of data base and possible continuous improvement of education in the sphere of genetics/genomics of all system participants. Meanwhile, CPMC participants can get access to the web portal and participate in the study free of charge. Unidentified genotypic and phenotypic results of participants who decided to release their data will be available to certified scientists for subsequent analysis.

Close collaboration with municipal hospitals, and not large clinical centers only, encourage participation of physicians in personalized medicine.

The programs will enable to build a foundation of the new type of healthcare in order to:

- implement the new model of translational medicine;
- form a subsystem of subjects that would unite researches, provision of medical aid and health data;
- destruct traditional isolated structures, which represent barriers for rapid discoveries and acquisition of knowledge;
- accelerate and increase the productivity of studies and improve clinical outcomes.

Development of these programs in the Russian Federation and their proper financing would enable fast introduction of the principles of personalized medicine into real clinical practice and notably oncology where the demand is significantly higher as compared with other areas of medicine.

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