Main Topic:
Information-based Prevention in Healthcare

Editors:
Milan Tuček and Jana Zvárová
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Czech Republic
EU VAT ID: CZ25666011

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Information Based Prevention in Healthcare

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The special topic of the International Journal for Biomedicine and Healthcare contains the papers presented at the symposium Information based prevention in healthcare held June 16th 2015 in Prague, The Czech Republic. The symposium has been organized by the EuroMISE Mentor Association in cooperation with the Czech Medical Society J. E. Purkyně, Society of Occupational Medicine under the auspices of Charles University in Prague, 1st Faculty of Medicine. The symposium addresses the important field by linking prevention in healthcare to gathered information. Information collected as data and knowledge is crucial for preventive healthcare decisions. This issue is one of key topics of preventive medicine and other disciplines, e.g. public health, hygiene, epidemiology, occupational medicine, family medicine and clinical disciplines.

The symposium will be introduced by two invited speakers. Prof. Izet Masic (Sarajevo, Bosnia and Herzegovina) presents Determinants of health and health concepts according to WHO targets, and Assoc. Prof. Ladislav Dušek (Brno, The Czech Republic) addresses Architecture and implementation of information strategy serving population-based cancer screening programmes in the Czech Republic. In this issue the published articles are alphabetically ordered by the name of the first author.

The Bencko’s paper shows that the traditional approaches and study designs in cancer epidemiology have not been very successful in identifying and adequate evaluating the potential risk and/or protective factors associated with the disease. Multicentre study is proposed as a way to increase study size and to mitigate criticism about meta-analysis of independent studies. An example is provided to demonstrate how biomarkers of exposures could provide valuable information in addition to exposure measurements in traditional epidemiological studies.

The Dušek et al. paper presents three evidence-based cancer screening programs (screening for breast cancer, colorectal cancer, cervical cancer) that have been running in the Czech Republic as recommended by the Word Health Organization and the Council of European Union. The strongest point of the study is the accessibility of information over a 34-year period of continuous and standardized registration covering virtually 100% of cancer diagnoses within the Czech population. The future aim is to facilitate the individual linkage of different data sources with the help of innovative legislation and to use these tools to contribute to the reduction of cancer mortality.

The Hynek et al. paper shows the study developing a new method of screening for fetal aneuploidies based on the detection of deviation in the distribution of cfDNA in maternal plasma using three innovative approaches: the number of reads expressed in multiple of median (MoM), chromosomal fingerprint and exponentially weighted moving average chart (EWMA), which enables to look at the distribution of reads alongside the relevant chromosome. The new MoM-based approach using chromosomal fingerprint and EWMA has a high performance in noninvasive aneuploidy screening with high sensitivity and low false positivity. Further information will be available from the current ongoing clinical phase.

The Masic’s paper discusses determinants of health and health concepts according to WHO targets. There are 6 basic principles of health for all: a) reducing inequalities in health; b) disease prevention and health promotion; c) cooperation among different sectors of society; d) community participation; e) primary health care; f) international cooperation. One of basic Global Health Strategic document of WHO is: Health for All for 21st Century, World Health Organization, Regional Office for Europe, Copenhagen, 1998.

The Muný et al. paper presents how to design, develop and evaluate usability of a diabetes smartwatch application. Bidirectional synchronization with an existing mobile phone diabetes diary was considered as necessary, primary feature for the application.

The Peška and Rotal’s paper shows how to analyze data from home blood pressure monitoring using electronic logbook. It contributes to a greater involvement of the patient in blood pressure monitoring and increases effectiveness of general practitioner due to the structured ready results in treatment of the disease.

The Slovák and Zvárová paper shows that the DNA analysis is considered to be an absolutely reliable process, but this conviction is not based on realistic foundations. Increasing sensitivity of methods of forensic analysis allows to investigate diminishing amount of biological material. With this development do not keep up legislation (attending obtaining DNA samples, their application
and subsequent retention in DNA databases) or mathematical methods. Even for commonly used methods, detailed derivation rarely exists; very often unambiguously accepted definitions of terms used are absent, which can lead to erroneous interpretations and biased or even completely meaningless results. Current approaches, unfortunately, can lead to very different match statistics on the same DNA data and the development in this field therefore aims to standardize the methods in use.

The Vlasáková et al. paper discusses the telemonitoring system solving the following problem: The amount of carbohydrate intake, injected insulin dose and the level of physical activity are the most significant factors that influence the metabolic compensation of the type 1 diabetes. These parameters can be measured by many technical tools. However, there is a problem with the assessment of the enormous amount of data and its heterogeneity. The proposed telemonitoring system offers a technical solution for data collection, sharing and centralization of measured parameters of each patient.

The Tuček’s paper informs about the occupational health risk and health impact assessment and necessary information facilitating correct medical fitness assessment for work based on system of categorization of work operations (Czech national database KAPR) and database of occupational diseases (OD). The prediction of occupational disease in correlation to the risk category based on number of persons working in risk categories is important for general perception of risks and decision making about the relevant coverage of working population by occupational health/medical services.

Zvára et al. paper shows a new model of the structured electronic oral health record (EOHR) for dentistry with the lifetime interactive DentCross component focused on multilingual applications in dental care. The design of EOHR was proposed in such a way that both narrative medical reports and coded data can be stored simultaneously.

Zvolský’s paper presents information on the Czech system of National health registries that covers information about serious diseases. The administrator of the health registries is the Institute of Health Information and Statistics of the Czech Republic (www.uzis.cz). Mortality statistics is provided in cooperation with the Czech Statistical Office.

The editors would like to thank all the authors for their excellent work as well as to the reviewers for lending their expertise to the symposium.
The Use of Epidemiological Data for Cancer Risk Assessment in Persons Exposed to Carcinogenic Agents

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Abstract

The traditional approaches and study designs in cancer epidemiology have not been very successful in identifying and evaluating adequately the potential risk and/or protective factors associated with the disease. The main reasons for the failure are often due to small study sample size, and inadequate exposure information. In this paper, we discuss issues and approaches relevant to these two challenges.

Multicentre study is proposed as a way to increase study size and to mitigate criticism about meta-analysis of independent studies. A multicenter study of large cohort or case–control studies also offers an exciting opportunity to study the contribution of epigenetic events that may be associated with life-style and environment risk factors for human health. Optimizing methods for exposure assessment and how to reduce exposure misclassification represent a difficult component in epidemiology studies.

A potentially useful approach for improving exposure estimate is to rely on biomarkers of exposures. An example is provided to demonstrate how biomarkers of exposures could provide valuable information in addition to exposure measurements in traditional epidemiological studies. Finally, it is argued that risk assessment and the precautionary principle should not be viewed as conflicting paradigms but, rather, as a complementary approach for developing appropriate policies to address risks posed by exposure to carcinogens and a wide spectrum of other health hazards.

Keywords

Epidemiological data, risk assessment, precautionary principle, cancer epidemiology, carcinogenicity, multicentre studies, genomics of cancer, epigenomics

1 Introduction

The field of epidemiology has reached a crucial point with challenges and opportunities. In one hand, it seems that most of the major occupational carcinogens have already been identified. Many of chemicals classified as carcinogens by the International Agency for Research on Cancer (IARC) were first evaluated in the workplace. In the last decades, occupational exposure to known human carcinogens has diminished in many countries and awareness of their hazard has increased. On the other hand, we are still confronted with a long list of substances for which epidemiological data are lacking or inconclusive. Estimates of the number of chemicals in commerce range from tens of thousands to over 140,000; for most of them, relevant toxicological information needed for setting up regulatory standards are still lacking.

We are now at an important crossroad; advances in the interrelated disciplines on which health risk assessment depends hold promise for comprehensive understanding of the influence of environmental stressors on human health. Last decades have been marked with major developments in the field of cancer risk assessment. There have been remarkable advances in the broad area of cancer epidemiology, including researches not only on human exposures to major cancer risk factors in environmental and occupational settings, but also on lifestyle and nutrition related risks. The traditional approaches and study design in cancer epidemiology have not been successful in identifying and evaluating these potential risk and/or protective factors. Two main reasons for this failure are often due to insufficient study size, and inadequate exposure assessment. In this paper, we discuss issues and approaches relevant to these two challenges, and the new opportunity of using emerging genomics information in epidemiology studies.
2 Increasing Study Size

An important characteristic of research in the last decade is the increasing number of collaborative studies involving various countries, and thus as a consequence, sample size is greatly increased. By increasing the sample size, the power of a study to identify significant associations between exposures and a disease endpoint is enhanced. For example, considering that lifetime prevalence of occupation-related exposures in the population is low (typically below 5 or 10%), and the associated risk can be small as well (e.g. relative risk of 2), the study sample size for a community-based study must be large in order to identify statistically significant associations. This is even more crucial if exposure or disease outcome is misclassified in a study population. A sample size of at least 1000 cases and controls has been recommended for a community-based case-control study on cancer. However, it is often the case that one centre or one country cannot provide such numbers within a reasonable amount of time. Therefore, multicentre studies are an obvious solution. Besides increased power, multicentre studies can provide additional advantages that include greater exposure contrast in the study population which is useful for exposure-response analysis, and an opportunity to study differences in exposure and disease patterns between countries.

Multicenter studies can be realized in two different ways. Collaboration between centres can be initiated after completion of each individual study (retrospectively planned multicenter studies), or before the studies have actually started (prospectively planned multicenter studies). Meta- and pooled analyses are examples of retrospectively planned multi-centre studies, and have been performed in many areas of epidemiology. Prospectively planned multicenter studies have only recently become possible since international organizations and institutions such as the European Commission started to offer funding for these costly operations. These studies offer advantage of identical protocol for data collection in each centre involved, and avoid loss of information at the stage of data pooling. From the Central and East European Countries (CEEC) perspective, an important example of this approach is the CEEC Multicenter Lung Cancer Study that was organized by IARC/WHO/Lyon, France about 10 years ago, and was supported by EC Inco Copernicus FP4. It represented collaboration of centres in the Czech Republic, Hungary, Poland, Rumania, Russian Federation, and Slovakia [3]. Later on the same organizational principle was applied in the Kidney Cancer Study supported by NCI/Bethesda, USA [4].

A pleasant surprise and great advantage from the concept of multicenter studies is that the potentially serious problems associated with the use of Meta analysis in observational studies can now be substantially mitigated. Merit of applying Meta analysis to observational studies has been questioned and controversial [5] because errors and biases can be easily introduced when studies with different designs, method, and population characteristics are combined. It would not be a problem if the study design is comparable, and method for data collection is coordinated prior to the initiation of the study among different centres. There are many factors that make Meta analysis of individually conducted studies less appropriate. Consider, for example, Meta analysis of odd ratios or relative risk estimates that require auxiliary information such as age, sex, smoking status, sample size. If all auxiliary variables are homogenous across studies, it would be appropriate to conduct Meta analyses of these studies [6,7]. In reality, these conditions have never been satisfied. Therefore, the concept of multicenter study offers an attractive alternative to the traditional single-centre epidemiological study.

3 Improving Exposure Assessment

Optimizing methods for exposure assessment and reducing exposure misclassification represent the most difficult components of epidemiology studies. A perfect exposure assessment for long latency diseases such as cancer would consist of quantitative measurements of internal dose, over the whole exposure period, for each subject in the study. This is a utopia unlikely to attain in the near future. The availability of group-based external exposure measurements in some points in time is already a luxurious proposition for epidemiologists trying to estimate the exposure of study subjects. More often one has to fall back on subjective methods of exposure assessment. The possibilities for exposure assessment largely depend on the design of the epidemiological study, with community-based and industry-based studies imposing their own specific limitations. In community-based case-control studies, the exposures of interest often cannot be measured directly, and have to be estimated retrospectively. As a consequence, exposure estimates are often based directly on the job-information provided by the study subjects (or proxies), or inferred from the job-information through job-exposure matrices or by expert assessment case-by-case. The subjectivity and the limited use of data-driven quantitative estimates of exposure used in case-control studies are considered important shortcomings that can lead to substantial exposure misclassification. How to improve retrospective exposure assessment methods has been of frequent debate. The difficulty in evaluating the validity of all retrospective exposure assessment methods in the absence of a gold standard is considered a major shortcoming. Reliability studies indicate that a considerable amount of misclassification can occur in all retrospective methods [8]. There is, however, an urgent need to quantify levels of misclassification expected from each method in order to anticipate on the attenuation of the resultant odds ratio (OR) estimates. A major area of improvement needed is the departure from crude exposure indicators such as never/ever exposed towards a more quantitative exposure assessment covering the entire exposure period. Quantitative exposure data that enable the investigation of the exposure-response relationship is an important cri-
terion for causation. The availability of quantitative exposure data also facilitates valid comparison of risk and exposure-response relations among studies, countries and industries, and provides a solid base for risk assessment and standard setting.

A potentially useful approach for improving exposure estimate is to rely on biomarkers of exposures. The use of biomarkers for exposures in health risk assessment has been around for a long time but its potential use in risk assessment does not seem to have been fully exploited. The utility of biomarkers is greatly enhanced when body burden was a result of exposure from multiple sources, or when source of exposures is difficult to identify such as exposure to second hand smoke. There are situations where biomarkers of exposures could provide valuable information in addition to measurement of exposures in traditional epidemiological studies. For instance, when data obtained from epidemiological studies of a community with high arsenic contamination in drinking water is used for risk assessment, a contentious issue is: what is the total arsenic intake for a person? Assessment of exposure is often based on the measured concentrations in the drinking water and estimations of the amount of water consumed and used for cooking, and an estimate of dietary intake. Under these uncertainties, biological monitoring that provides data on the absorbed dose for each individual studied offer a useful solution to the problem. Biomarkers may include arsenic in urine, blood, hair, and nails. However, suitability of the various biomarkers to serve as indicators of acute or chronic exposure to inorganic arsenic and the various factors needs to be carefully evaluated. Although the objective here is not about arsenic risk assessment, we use it as an example to illustrate the potential utility of biomarkers. Epigenomics – New challenges and opportunities

While the field of cancer genetics has enjoyed a great deal of attention among cancer researchers in the last few decades [1] [2], the appreciation of cancer epigenetics is more recent. The study of the role of epigenetic changes induced by environmental, dietary and lifestyle factors is rapidly emerging but still in its infancy; little is known about the precise contribution of epigenetic mechanisms to different types of human health effects induced by adverse stimuli in the environment and diet. While there is accumulating evidence showing that aberrant DNA methylation may result from adverse exposures to epimutagens, there is a paucity of evidence regarding the effects of stimuli causing heritable changes in epigenetic information stored in histones, owing to the fact that this is a new and largely unexplored field. Although it seems inevitable that perturbations in histone modifications are induced by dietary and environmental factors that contribute to the development of human disease such as cancers, a rigorous proof of such a relationship remains to be established [3].

Multicenter and large cohort or case–control studies offer some of the most exciting opportunities to study the contribution of epigenetic events induced by the diet and environment to human cancer. Such examples are the objectives of the European Prospective Investigation into Cancer and Nutrition, a large prospective cohort study designed to investigate the relationship between diet, lifestyles, and the incidence of cancer in 10 European countries [10]; and a case–control study on lung and upper-aerodigestive tract cancers in Central and Eastern Europe [11] [12]. These multicentre studies boast a large sample size of several thousand subjects, and represent a unique possibility to identify which dietary/lifestyle practices, and environment stimuli may exert risk and/or benefit effects through epigenomic changes.

Epigenetic alterations in comparison with genetic changes are reversible and are typically acquired in a gradual manner. These features offer an important potential opportunity for prevention strategies [9].

4 Risk Assessment

Risk assessment is an evolving science, and methods for conducting risk assessment are still at an infant stage, although undergoing rapid development. One of important aspects of a recent discussion is about cessation lag and effect lingering and their potential applications to dose-response analysis in risk assessment [13] [14]. In addition to providing insight about biological mode of action, concept of cessation lag is useful for economic benefit analysis. Effect lingering can be used to analyze epidemiological data by uncovering the hidden biological implications related to disease endpoints, thereby advancing current efforts to characterize and reduce risk assessment uncertainties. Controversies abound concerning the appropriate methods and data to use and they are likely to persist, giving the great uncertainties involved in extrapolating beyond the range of available data, the underlying biases and other limitations of observational data [15] [16] and the political and societal implications of these analyses [11] [2]. Skeptics have argued that risk assessment, at least as it is currently practiced, has not been a useful tool for addressing societal concerns about exposures to environmental and occupational hazards [17]. Their primary concern is that the increasingly intense debates concerning risk assessments may come to be used as an excuse for delay in the development of appropriate regulatory and other responses to environmental and occupational hazards. For example, it has taken the U.S. EPA more than 20 years to finalize its risk assessment for exposure to diesel exhaust particulates [18].

A spirited debate has emerged over the use of the “precautionary principle” as an alternative basis for public health decision-making, and this approach has recently been embodied in some environmental legislation of the European Union [19]. The precautionary principle has been defined as the need to take some precautionary measures to prevent threats to human health even when a cause-and-effect relation has not been fully established [20]. We all know the story of how John Snow convinced the authorities to remove the Broad Street pump well before the cause of the cholera epidemic in London was
properly understood \[1\] [21]. In our view, risk assessment and the precautionary principle should not be viewed as conflicting paradigms but, rather, as complementary approaches for developing appropriate policies to address risks posed by exposure to carcinogens and other hazards. Identification and quantification of risks is clearly a useful tool for informed decision-making. Appropriately, this is also the underlying principle for the current USEPA’s default approach for cancer risk assessment. This is not a new principle for epidemiologists. Risk assessments are inherently uncertain and should, as the NAS (1996) suggested, be viewed as an iterative process in need of continual improvements through research targeted to fill the gaps in our evidence based knowledge. Tremendous advances in our understanding of basic epigenetic mechanisms and rapid progress that is being made in developing new powerful technologies, such as those for sensitive and quantitative detection of epigenetic changes as well as for genome-wide analysis (epigenomics), hold great promise that these issues may be addressed in foreseeable future [9].

5 Conclusions

Epidemiological data play a crucial role in the evidence-based cancer risk assessment and classification of human carcinogens. With the rapid emerging genomic and molecular data, and adoption of multicenter study concept, there is a real hope that foreseeable future will bring long awaited answers to the problems we encounter today, such as the impact of aberrant genetic and epigenetic interaction with environment and diet. This new biological information could lead to discovery of new exposure and/or effect biomarkers and development of novel strategies for health risk assessment and analysis.

Acknowledgements

The author acknowledges sincere thanks to Dr. Chao Chen of the US EPA for his constructive comments that help to improve the paper which was written within activities supported by the League Against Cancer, Prague.

References


Architecture and Implementation of Information Strategy
Serving Population-based Cancer Screening Programmes in the Czech Republic: Lessons Learned from the Management of Multiple Data Sources

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Abstract

All three evidence-based cancer screening programmes (screening for breast cancer, colorectal cancer, cervical cancer) have been running in the Czech Republic, as recommended by the World Health Organization (WHO) and the Council of the European Union. Systems for individual data collection and performance monitoring are implemented in accordance with the valid international guidelines. The information system is designed as multimodal, covering all necessary levels: population monitoring via a nationwide registry of cancer epidemiology, diagnostic registries of screening centres, and administrative registry of health care payers. The strongest point of the present study lies in the accessibility of information over a 34-year period of continuous and standardised registration covering virtually 100% of cancer diagnoses within the entire Czech population. The data summary is also available for the public as an interactive on-line tool (www.svod.cz).

In 2014, a system of personalised invitations was implemented in the data centres of health care payers and in one year, nearly 2 millions of inhabitants were invited to the screening programmes. The system reached a participation rate ranging between 10% and 15%, and significantly increased the screening coverage (colorectal screening: > 32%, breast and cervical screening: both > 55%). An active on-line reporting supports the system sustainability. All relevant guidelines, outcomes and reports of the screening programmes are available on the websites www.mamo.cz, www.cervix.cz, www.kolorektum.cz. The main challenge for the future is to facilitate the individual linkage of different data sources with the help of innovative legislation, and to use these tools to contribute to the reduction of cancer mortality.

Keywords

Cancer Prevention, Cancer Screening, Information System

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IJBH 2015; 3(2):7–11
received: April 30, 2015
accepted: May 6, 2015
published: June 15, 2015

1 Introduction

Programmes for an early detection of malignant tumours are among the top priorities of cancer control and management in Europe. According to the results of many epidemiological and clinical studies, screening programmes can effectively reduce mortality of three cancer types: breast cancer, colorectal cancer, and cervical cancer [1 2 3 4 5 6]. In 2003, European Council [7] recommended that all member states of the European Union adopt organised cancer screening programmes in accordance with the European guidelines. The annex of this recommendation states that its requirements are fulfilled by three cancer screening modalities:

- pap smear screening for cervical cancer precursors starting not before the age of 20 and not later than the age of 30,
- mammography screening for breast cancer in women aged 50 to 69 in accordance with the European guidelines on quality assurance in mammography,
- faecal occult blood screening for colorectal cancer in men and women aged 50 to 74.
However, it is evident that only a highly organised screening programme can reach effectively its principal aim, which is a significant reduction of the population burden, mainly mortality rates [8]. That is why the European Council and international expert teams strongly recommended systems of personalised invitations, inviting citizens to participate in screening examinations. This population-based approach certainly cannot be implemented without a robust information background, which must cover all necessary levels of the programme management: a call-recall system controlling the participation rate, quality monitoring, performance indicators and finally epidemiological monitoring of outcomes.

Functionality of the required information system can be derived from the already published European guidelines for cancer screening quality assurance, coordinated by the Screening Quality Control Group at the International Agency for Research on Cancer. Up to the present time, the European Commission issued the European Guidelines on breast cancer screening [9], cervical cancer screening [10] and colorectal cancer screening [11].

Figure 1: Diagnostic registry of the Czech breast cancer screening programme.

This study is primarily aimed to introduce the Czech national information system for cancer screening programmes, its architecture and outcomes. The second objective is to describe the newly implemented system of personalised invitations, which has demonstrably increased the participation rate of citizens in cancer screening programmes.

2 Cancer Screening Programmes in the Czech Republic

The Czech National Cancer Control Programme (www.linkos.cz; www.onconet.cz) was officially launched in 2003, in accordance with the conditions and needs of the Czech Republic, and in compliance with the conclusions of WHO Consultation on Strategies to Improve and Strengthen Cancer Control Programmes in Europe [12]. The organised cancer screening programmes (Table 1) form a very substantial part of the national cancer control programme:

- An organised breast cancer screening programme was launched in September 2002.
- A nationwide colorectal cancer screening programme was started in 2000, employing faecal occult blood test to be performed in a two-year interval. Starting from 2009, people aged over 55 years can opt for colonoscopy every 10 years as a screening test.
- Starting from 2008, the opportunistic system of cervical cancer prevention has been transformed to a nationwide cervical cancer screening programme. In January 2008, a network of accredited screening cytology centres was established.

3 Information System of the Czech Cancer Screening Programmes

LEVEL 1 – POPULATION MONITORING

The Czech National Cancer Registry (CNCR) was launched in 1977 as a national database covering 100% of cancer diagnoses. CNCR is equipped with an information system which, among others, provides a freely accessible analytical website www.svod.cz [13]. Table 2 brings an example of population monitoring of cancer types targeted by the screening.

Figure 2: Diagnostic registry of the Czech colorectal cancer screening programme.

LEVEL 2 – DIAGNOSTIC REGISTRIES OF SCREENING CENTRES

As required by the EU Council Recommendation on Cancer Screening, data on screening tests and following diagnostic procedures are regularly collected in all health
Table 1: Cancer screening programmes implemented in the Czech Republic.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Target population</th>
<th>Screening method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast cancer</td>
<td>Women over 45 years of age</td>
<td>Mammography once per 2 years</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td>Men and women over 50 years of age</td>
<td>Faecal occult blood test once per year</td>
</tr>
<tr>
<td>Cervical cancer</td>
<td>Women over 15 years of age</td>
<td>Pap smear cytology examination once per year</td>
</tr>
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LEVEL 3 – UTILISING THE HEALTH INSURANCE DATA FOR QUALITY CONTROL

In the Czech health care system, most of the medical procedures relevant to secondary cancer prevention are reimbursed from the public health insurance by one of the health insurance companies. Health insurance data contains information on all faecal occult blood tests performed in the target population. In a similar fashion, health insurance data can be employed in cervical screening. It is necessary to obtain retrospective information on the prevalence of opportunistic smears before the screening became organised. These data can also help to put proposed cervical cancer screening monitoring system in the context of complete screening process (including treatment of cancer and precancerous lesions).

Another very important role of health insurance companies is the implementation of a system of personalised invitations. In the Czech Republic, such system was launched in 2014, shifting the design of screening programmes definitely towards an internationally recommended form of population-based screening programmes. In this system, health insurance companies invite their clients in which a long-term non-attendance to this form of prevention has been previously identified. Data on these clients are collected in a database over which a mechanism containing a set of SQL routines is implemented, deciding on whether the clients should or should not be involved in individual screening programmes.

4 Comprehensive Architecture of the Information System

Figure 4 shows the architecture and interconnection of components involved in the evaluation of the Czech cancer screening programmes. Data interfaces have been designed in compliance with valid data standards and classifications, and provided data exports therefore ensure a semantic interoperability among the involved systems. In particular, the supported classification and standards involve:

- International statistical classification of diseases and related health problems (World Health Organization, 1992; ICD-10; 10th revision)
- International Classification of Diseases for Oncology (World Health Organization, 2000; ICD-O; 3rd revision)
- Staging classification according to TNM classification systems, 7th edition (Sobin et al., 2009)
- Standardised Death Certificates (World Health Organization, 2014)
- Data standards of the National Health Information System (Ministry of Health, data.mzcr.cz)
Table 2: Recent trends in the epidemiology of screening-targeted cancers in the Czech Republic. Source: CNCR.

<table>
<thead>
<tr>
<th>Period</th>
<th>Breast cancer (C50)</th>
<th>Colorectal cancer (C18-C20)</th>
<th>Cervical cancer (C53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(per 100,000 persons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-2007</td>
<td>115.02</td>
<td>78.35</td>
<td>19.57</td>
</tr>
<tr>
<td>Change (%)</td>
<td>+6.81</td>
<td>+0.08</td>
<td>-4.45</td>
</tr>
<tr>
<td>2008-2012</td>
<td>122.85</td>
<td>78.41</td>
<td>18.70</td>
</tr>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(per 100,000 persons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-2007</td>
<td>38.92</td>
<td>42.84</td>
<td>8.05</td>
</tr>
<tr>
<td>Change (%)</td>
<td>-7.12</td>
<td>-8.50</td>
<td>-7.62</td>
</tr>
<tr>
<td>2008-2012</td>
<td>36.15</td>
<td>39.20</td>
<td>7.31</td>
</tr>
<tr>
<td>Mortality ASR(E)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-2007</td>
<td>27.24</td>
<td>33.26</td>
<td>6.33</td>
</tr>
<tr>
<td>Change (%)</td>
<td>-15.09</td>
<td>-16.09</td>
<td>-13.43</td>
</tr>
<tr>
<td>2008-2012</td>
<td>23.13</td>
<td>27.91</td>
<td>5.48</td>
</tr>
</tbody>
</table>

Figure 4: Complex architecture of the cancer screening information system of the Czech Republic.

5 Conclusion

To conclude, all three evidence-based cancer screening programmes have been running in the Czech Republic, as recommended by the World Health Organization (WHO) and the Council of the European Union. Systems for individual data collection and performance monitoring are implemented in accordance with the international guidelines issued by the European Commission. The system sustainability is supported by an active on-line reporting; all relevant guidelines, outcomes and reports of the screening programmes can be found on the national websites www.mamo.cz, www.cervix.cz, www.kolorektum.cz [14, 15, 16]. Despite the heterogeneity of systems employed for the monitoring of personalised invitations, respecting data standards and using data interfaces con-
tributed to the unification of key data sources; in this way, a functioning system for the monitoring of screening programmes has been developed. It is very likely that the described solution, which focuses mainly on the integration of available data sources, is a viable concept for the evaluation of other screening programmes, and that the described concept of integration might find a relevant applicability in other countries, too.

Acknowledgements

This work arises from the CanCon joint action, which has received funding from the European Union in the framework of the Health Programme.

References


MoM-based Approach to Noninvasive Prenatal Testing Using Exponentially Weighted Moving Average Chart and Chromosomal Fingerprint

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IJBH 2015; 3(2):12–15
received: May 1, 2015
accepted: May 12, 2015
published: June 15, 2015

Introduction

The discovery of cell-free fetal DNA (cfDNA) in maternal plasma in 1997 \cite{1} opened up new possibilities for noninvasive prenatal testing (NIPT). However, fetal DNA represents only a minor fraction of total DNA in maternal plasma \cite{2}, which makes the NIPT challenging. The development of massive parallel sequencing (MPS) methods, which can identify and quantify millions of DNA fragments (reads), including a small fraction originated from the fetus, enabled to detect small changes in the representation of chromosomes contributed by an aneuploid fetus in a maternal plasma \cite{3}. Basically, most current NIPT tests use whole-genome MPS in order to quantitatively compare the amount of DNA fragments from the chromosome of interest, for example chromosome 21, in a maternal sample with that of an euploid reference sample. Other methods include targeted sequencing, mapping only the chromosome regions of interest, or a qualitative SNP-based approach \cite{4}.

In an updated recent meta-analysis, detection rates and false-positive rates for NIPT were found 99.2\% and 0.09\%, respectively, for trisomy 21, 96.3\% and 0.13\% for trisomy 18 and 91.0\% and 0.13\% for trisomy 13 in singleton pregnancies \cite{5}.

The aim of this study was to develop a new method of screening for fetal aneuploidies based on the detection of deviation in the distribution of cfDNA in maternal plasma using three innovative approaches: the number of reads expressed in multiple of median (MoM), chromosomal fingerprint and exponentially weighted moving average chart (EWMA), which enables to look at the distribution of reads alongside the relevant chromosome.

Methods

Study Population

The cohort for this study consisted of 272 women with singleton pregnancies and known fetal karyotype. Maternal venous blood samples (10mL in Streck cell-free DNA BCT\textsuperscript{TM} tubes) were obtained between 10 and 22 weeks of pregnancy. Appropriate informed consent was obtained for all study participants. The cohort was divided into two groups. Group I, which included 93 pregnancies with euploid fetuses, was used to construct reference range. Groups II, which consisted of 179 pregnancies (145 with euploid fetuses, 3 with fetuses with trisomy 13, 9 with trisomy 18 and 22 with trisomy 21) was used as a testing group to assess the suggested approach.

Sample Processing and DNA Sequencing

The blood samples were first centrifuged at 1,600 g for 10 minutes at room temperature as to separate the plasma from peripheral blood cells. The plasma portion was carefully transferred to a new sterile 15 mL tube and then subjected to another centrifugation at 3,200 g at room temperature. Plasma DNA was extracted by using QIAamp Circulating Nucleic Acid Kit (Qiagen, Hilden, Germany).

The DNA libraries were prepared from the extracted plasma DNA using Ion Plus Fragment Library Kit (Life Technologies, USA). Subsequently, the DNA library were
measured and equimolarly pooled. Finally, the whole-genome single-end sequencing using Ion Proton™ System (Life Technologies, USA) was performed.

Data Analysis

The reads obtained from one end of each sequenced plasma DNA molecule was first mapped to the human genomic reference sequences (hg19) using the Torrent Mapping Alignment Program v4.0-R77189 (Life Technologies, USA). The reads with mapping quality below 50, unmapped reads, duplicates and reads with the length shorter than 35 kb or longer than 180 bp were removed. The number of reads from each 60 kb segments (bins) on each chromosome were counted together with the average GC content. Bins with GC content higher than 0.55 and lower than 0.35 were filtered out.

Statistical Analysis

All statistical analyses were performed using the statistical computing environment R [6] and the R package qcc for quality control charts [7].

The statistical analysis consists of several consecutive steps. First, the effect of GC bias was corrected by LOESS regression, as previously published [8].

Second, intersample and interrun sequencing variation in the chromosomal distribution of sequence reads can obscure the effects of fetal aneuploidy on the distribution of mapped sequence sites. To minimize such variability in the absolute numbers of GC-corrected reads per bin, we used for the subsequent analysis rather the number of GC-corrected reads per bin expressed in MoMs when the sample median was defined as the median of GC-corrected number of reads belonging to chromosomes 1–10.

Third step included the use of chromosomal fingerprints. Because we have found out that the bins belonging to the particular chromosome are not sequenced identically, we constructed ‘chromosomal fingerprints’, a kind of chromosomal maps, in which each bin is characterized by the mean and standard deviation of the number of reads in MoMs. The basis for the construction of fingerprints for chromosomes 13, 18 and 21 were the 93 euploid samples from Group I. An example of fingerprint showing the mean of the number of reads in MoMs for chromosome 21 is provided in Figure 1. It can been seen that although most bins have the average number of reads in MoMs around 1, there are bins with markedly lower or higher averages.

When testing samples from Group II, the deviation in the distribution of MoMs in every bin from the expected values of the particular fingerprint were expressed as Z-score:

\[ Z_{\text{MoM}} = \frac{x - \mu}{\sigma}, \]  \( (1) \)

where \( x \) is the number of reads per bin in MoMs in the tested sample, \( \mu \) is the mean and \( \sigma \) is the standard deviation of the number of reads in MoMs in the corresponding bin of the fingerprint. To check the Z-score concept, we calculated \( Z_{\text{MoM}} \) for all samples from Group I and subsequently constructed normal probability plot which did not show a marked departure from normality.

Fourth, to assess the distribution of Z-scores along the chromosomes 13, 18 and 21, the EWMA charts were used. EWMA represents a quality control tool used to detect the undesired shift in the process. EWMA is a type of moving mean that adopts a varying weight scheme. The highest weight is assigned to the most recent observation, and the weights of the past observations fall off exponentially in a geometric series. EWMA is based on the following statistics [9]:

\[ Z_i = \lambda x_i + (1 - \lambda)Z_{i-1}, \quad 0 < \lambda \leq 1 \]  \( (2) \)

where \( x_i \) is the current observation (in our case \( Z_{\text{MoM}} \)) and \( \lambda \) is the weighting constant that determines the rate of decay for the weights. The upper control limit (UCL) and lower control limit (LCL) are placed symmetrically about the process target \( \mu_0 \), as follows [9]:

\[ \frac{\text{UCL}}{\text{LCL}} = \mu_0 \pm k\sqrt{\frac{1 - (1 - \lambda)^2}{2 - \lambda} \sigma_x} \]  \( (3) \)

where \( k \) determines the width of the control limits in standard deviation units. The statistics \( Z_i \) is continuously calculated and plotted on the chart with UCL and LCL, thus producing a single curve for which departures beyond the control limits indicate the out-of-control process. Therefore, the departure of EWMA curve above UCL detects the shift in the expected distribution of number of reads and indicates a high risk of trisomy. Based on our previ-
ous extensive experience with EWMA charts [10, 11], the weighting constant $\lambda$ was set to 0.01 and the width of the control limits $k = \pm 2.9$.

As for the expected process targets $\mu_0$ and $\sigma$, we calculated the averages and standard deviations of $Z_{MoM}$ in Group I samples and assessed how they changed with the number of reads. In case of the averages, they were randomly distributed around 1 regardless of number of reads. However, in case of standard deviations, there were an obvious dependency with the number of reads which could be described by negative power function $\sigma = 1535.716 + (\text{number of reads})^{-0.4916}$ (Figure 2). Therefore, when constructing EWMA, we used $\mu_0 = 1$ and the actual standard deviation of $Z_{MoM}$ in the tested sample as $\sigma$.

Finally, fetal gender was assessed by counting of the number of bins on chromosome Y in which at least one read was present.

**Results**

Overall, 272 maternal blood samples were analyzed. The results of 93 euploid samples (Group I) were used for the construction of fingerprints, as already mentioned. The 179 Group II samples were analyzed and EWMA charts produced. What we would expect is that in euploid samples the EWMA curves for chromosomes 13, 18 and 21 stays within control limits (Figure 3A). Conversely, in cases of trisomic samples, the significant part of EWMA curve presenting the relevant chromosome departures above UCL (Figure 3B).

The overall results are summarized in Figure 4 showing the percentage of EWMA curves above UCL for all 179 samples for chromosomes 13, 18 and 21. In cases of trisomic pregnancies, all cases of trisomy 13, 18 and 21 showed more than 15 % of EWMA curve above UCL. Regarding 145 euploid samples, there were only 2 cases in which chromosome 21 presented more than 15 % of EWMA above UCL. Therefore, using a diagnostic cutoff point of 15 % EWMA curve above UCL, we would detect all cases of trisomic pregnancies and two cases would be false positives. It has to be point out that two euploid cases had the percentage of EWMA curve above UCL for
chromosome 18 just below the 15% cutoff and it is probable that they would also be regarded as false positives if tested in clinical settings.

Fetal gender was correctly identified in all cases. All male fetuses had the number of occupied bins on chromosome Y above 80, whereas all female fetuses below 30 (Figure 5).

Conclusions

The new MoM-based approach using chromosomal fingerprint and EWMA has a high performance in noninvasive aneuploidy screening with high sensitivity and low false positivity. The further information will be available from the current ongoing clinical phase.

Acknowledgements

The work was supported by the grant SVV-2015-260158 of Charles University in Prague.

References

Determinants of Health and Health Concepts According to WHO Targets

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Abstract

Health is one of the fundamental rights of every human being, a precondition for prosperity and quality of life indicator for measuring progress and the basis of steady economic growth. The health status of our population depends on a rapid changes, such as number of demographic, social, cultural, ethnical, and other characteristics which are for several decades in a very intensive changes, It refers to the structure of the population and the morbidity and mortality rates, the increase in the use of all forms of health care, as well as the representation and the ever-increasing list of individual risk factors for mass diseases and their consequences. There are 6 basic principles of health for all: a) reducing inequalities in health; b) disease prevention and health promotion; c) cooperation between different sectors of society; d) community participation; e) primary health care; f) international cooperation.

From a very practical reason, and in light of the multidimensional concept, were identified even fourth and fifth dimension health. Fourth as a consequence of the previous three dimensions of health, the general functional capability that includes not only the functioning of specific organs and systems, but also the ability of humans to perform odd: activities of daily life and fifth-subjective assessment of their own health condition that maintain all four of the aforementioned dimensions of health and contains a unique subjective information, such attitude and opinion, about their own health. This concept of great importance, especially when it comes to the study of the health status of the population and the degree of utilization of certain aspects of health protection.

Keywords

health, WHO targets, human rights, health determinants, needs, demands.

1 Introduction

Health is one of the fundamental rights of every human being, a precondition for prosperity and quality of life indicator for measuring progress and the basis of steady economic growth. The goals of the World Health Organization is highest level of achievement for all peoples health – health as a fundamental human right. Definition of health by the World Health Organization as follows: Health is a state of complete physical, mental and social well-being and not merely the absence of disease and exhaustion. Prof Andrija Stampar, founder of WHO in 1948 used the phrase that will fight for health for everyone (“Health for everyone”, ”health for everybody”). Today, the term changed to ”health for all”. In 1977, whatever. Declaration on Primary Health Care in 1978 in Alma-Ata is clearly mapped out the road to progress, not only buildings but its main development factors. In the interest of humanity HEALTH FOR ALL = ALL HEALTH. Governments are responsible for the health of its people, which can be satisfied only by taking appropriate health and social measures. The main social goal should be to achieve a level of health that allows socially and economically productive life for all members of all nations. Primary health care is the key to achieving this goal as part of development in the spirit of social justice.

The Assembly of the WHO’s International Community and the Member States sent a challenge: to achieve Health for all. To initiate a review of the foundations of health policy in 1984 member countries adopted the 38 goals of the regional strategy Health for All. In 1986 adopted the Ottawa Charter-health promotion is the process of strengthening the people to gain control over their environment and their health and thereby improve (change or adjust).

- Five strategies set out in the Ottawa Charter for Health is necessary for success:
- Building healthy public policy;
• Creating a supportive environment;
• Strengthening community action;
• Develop personal skills;
• Redirection of health services

2 Human and Patient’s Rights

Inequalities in health status of individuals and populations are inevitable [1, 2, 3]. Arise as a result of genetic differences, different social and economic conditions or the result of personal lifestyle choices. But inequalities in health arise as a result of differences in abilities (inequality in accessibility to health care, differences in housing, accessibility of healthy food ...). Health for All in the 21st century – fairness and solidarity. Inequalities in health are the result of unequal life opportunities. Poverty is a major cause of damage to health. In the a year 1820 differences between rich and poor was 3:1, and in 1992, 72:1; in 2000, only 40.8% of the world’s population lived in countries that respect the basic political rights and civil liberties. In 71 country (of 192 as it is today in the world) ruled undemocratically elected officials. Countries with developed democracy generate 86% of global GDP. Also, 90% of research and development resources are concentrated in developed countries. WHO should perform five key roles: a) Health conscience; b) The Information centre for health and development of health; c) The promoter of health policy; d) Provide effective instruments; e) To act as a catalyst for action.

The goal is to "strengthen" health through the creation of an environment conducive to health, through the expansion of social support, and capacity building of "vulnerable" groups.

The World Health Organization (WHO) explains that human rights provide a framework for reviewing procedures to individual governments and the international community as a whole, testing their responsibility for health through what they are or are not made for the better health of the people.

This is achieved by:

Promoting healthy lifestyles and reducing risk factors to human health resulting from environmental, economic, social or behavioral factors environment;

The development of the health system that promotes equitable health outcomes, corresponding to the eligible health requirements of the population, and which is financially equitable and based on policy and practice "of non exclusion" available (territorial and volume, e.g. waiting lists) accessible (financial, transportation and architecture, weather, culturally), efficient, financially sustainable, high quality, equitable, whose services suit the user’s needs and achieve the effect on health;

Development of health policy within the (institutional environment) health system and promoting the development policy which effectively address the social, economic and environmental dimensions of health – assessment of the impact on health development programs.

3 Basic Principles of Health for All

There are 6 basic principles of health for all [1, 2]

• Disease inequalities in health;
• Disease prevention and health promotion;
• Cooperation between different sectors of society;
• Community participation;
• Primary health care;
• International cooperation.

Within WHO, 166 member states unanimously adopted a program of health for all, based on:

• The technology must be technically suitable;
• The willingness of society to improve health;
• Cooperation of the health sector with other key actors;
• Participation of the whole society and individuals looking for better health.

4 "HEALTH 21" – Basic Global Health Strategic Document for the 21st Century

The strategic document called "Health 21" response of the European region to global strategy "Health for All" and as such determines the framework for action for the health of the region as a whole, thereby serving as inspiration for shaping health policy goals at national and local level [1, 2]. One of basic Global Health Strategic document of WHO is: Health for All for 21st Century, World Health Organization, Regional Office for Europe, Copenhagen, 1998. The policy of "Health for All in the 21st Century" European Department of the World Health Organization, consists of the following key elements:

• The only permanent goal is to achieve the full potential of health for all.
• The two most important objectives:
  • Improve and maintain health during the whole of human life and;
  • Reduce the incidence of major diseases and injuries of today, and to alleviate the suffering caused by them.

Securities principles underlying the strategy of "Health 21" are:

• Health is a fundamental human right,
• To achieve the goals necessary fairness and solidarity within and between countries and their inhabitants.

Achievement of objectives requires active participation as well as accountability to the constant development of the health of both individuals and groups, institutions and the community as whole.

The selected four key strategies for action should guide scientific, economic, social and political goals of sustainable implementation of Health, 21:

• Promoting initiatives in the consideration of social determinants of health, which recognizes the physical, economic, social, cultural as well as a gender perspective and ensuring the use of the assessment of health effects,

• Strategy that will select among programs and investments in the development of health and clinical care to be guided by the criterion of their impact on health,

• Strategy of integrated primary health care and family-oriented community, supported perceptive and adaptable system of hospital care and;

• Strategy of participatory development process involving all relevant partners for health in the home, at school, in the workplace, in the community and nationally, promoting shared decision-making, implementation and accountability.

The strategy was formulated in 21 targets for health for all, who stated needs of the entire European region and propose necessary actions to improve the situation. They will represent value against which to measure progress in improving and preserving health and reducing risk. Together, all 21 provide a strategic framework for the development of health policy in the European region.

The European section of the World Health Organization with its part should strongly support the adopted strategy and worked five key roles:

1. Be "health conscience", defending health as a fundamental human right, identifying and pointing to ongoing or emerging problems related to human health;

2. Act as a leading information center for health and development of health;

3. Be a promoter of health policy for all in the region, to ensure its monitoring and regularly update;

4. Put at the disposal of member states to effectively implement (contemporary, the

5. evidence-based tools, know-how) that they will be able to use when translating into action its policy of health for all;

6. Act as a catalyst for action.

5 Priorities for Health Promotion in the 21st Century

5.1 Promote Social Responsibility for Health

Policy makers and actors administration must be firmly adhered to the principles of social responsibility. 1 public and private sectors should promote leading health policies and practices that [1 2]:

• Avoiding harm the health of the individual;

• Protect the environment and ensure sustainable exploitation of resources;

• Limit the production of products and substances that are harmful in nature, such as tobacco and weapons, and their trading, marketing practices that discourage injurious to health;

• To protect the citizen in the market and the individual in the workplace;

• Include performance evaluation in health with a focus on equality as an integral part

• policy development.

5.2 Increase Investment in the Development of Health

• In many countries the existing investment in health insufficient and often ineffective. Increased investment in health development requires a true multi-sectorial approach, for example, includes additional funding for education and housing as well as for the health sector. More investment in health and redirecting existing investments both within and between countries could achieve significant progress in human development, health and quality of life.

• Investing in health should reflect the needs of specific groups such as women, children, the elderly, indigenous populations, the poor and marginalized people.

5.3 Strengthen and Expand Partnerships for Health

• Health promotion requires partnerships for health and social development of various sectors at all levels of government and society. It is necessary to strengthen existing partnerships and to examine the possibilities for the establishment of new ones.

• Partnerships offer mutual benefit for health through the sharing of expertise, skills and resources. Each partnership should be transparent, accountable and
based on ethical principles, mutual understanding and respect. Should follow the principles guiding the World Health Organization.

5.4 Increase Community Capacity and Empower the Individual

- Health promotion is made by people and it is working with the people and not the people or for the people. It improves as the individual’s ability to take action and the ability of groups, organizations or communities to influence the determinants of health.

- Improvement of community health promotion requires practical training, training in leadership (leadership), and access to resources.

- Empowerment of the individual seeking a more consistent approach to decision making, and skills and knowledge essential for achieving change. One traditional means of communication and new mass media support this process. Social, cultural and spiritual resources to be innovative ways to harness the benefits of health.

5.5 Provide Infrastructure for Health Promotion

- To build infrastructure for health promotion, must find new mechanisms for funding at the local, national and global level. Should develop incentives to influence the government, NGOs, educational institutions and the private sector to ensure maximum mobilization of resources to promote health.

- "Ambiance for health" (of health promotion) constitute a structural basis necessary infrastructure for health promotion. New challenges to better health imply also the need to create new and different networks

- for interagency coordination. Such networks need you to provide mutual assistance within the country and between countries, and to facilitate the exchange of information on strategies that have proven successful as in what areas.

- Must be encouraged education for local management and its practices to support health promotion activities. For better planning, realization and evaluation of health promotion should equally stimulate scientific research papers and publishing experience.

- All countries must endeavor to introduce political, legal, educational, economic and social frameworks that are conducive to the promotion of health.

5.6 Call to Action

The participants of this conference are committed to the key messages of this Declaration to share with its government, institutions and communities, and practically apply the proposed action and notify the Fifth International Conference on Health Promotion. To accelerate progress towards global health promotion, participants support the establishment of the World Union for Health Promotion. The aim is to promote EU priorities for action for health promotion set out in this Declaration.

Among the priorities of the Union are as follows:

- Increase awareness of the changing health determinants;

- Support the development of cooperation and networks for development of health;

- Mobilize resources for health promotion

- Accumulate knowledge on best practice;

- Enable shared learning;

- Promote solidarity in action;

- Encourage transparency and public accountability in health promotion.

- Invite the governments of the countries to undertake initiatives to promote health and sponsorship networks to promote health within and between countries.

Participants seeking from the World Health Organization to take the initiative for the creation of the World Union for Health Promotion and allow member states the conclusions of the Conference. A key part of this role for the World Health Organization will consist mainly in engaging governments, non-governmental organizations, development banks, agencies of the United Nations system, inter-regional organizations, bilateral organizations, the trade union movement and cooperatives, as well as the private sector to assist in the implementation of priority actions health promotion.

6 Health Concepts

When working on the study of the health status of the population and in particular the degree of utilization of individual type of health care, traditional, and sometimes exclusively biomedical approach that is oriented toward clinically overt disease or lethal outcome became not solve, especially in a situation of high prevalence of chronic diseases and the growing number of old, sick and disabled persons[1][2][10].
6.1 The Concept of "Five Dimensions of Health"

A general accepted definition of health proposed by World Health Organization observes "health as a state of overall physical, mental and social well-being and not merely the absence of disease or infirmity", which are measuring classically been identified three dimensions of health-physical, mental and social [6, 7, 8, 9, 10]. From a very practical reason, and in light of the multidimensional concept, were identified even fourth and fifth dimension health. Fourth as a consequence of the previous three dimensions of health, the general functional capability that includes not only the functioning of specific organs and systems, but also the ability of humans to perform odd: activities of daily life and fifth-subjective assessment of their own health condition that maintain all four of the aforementioned dimensions of health and contains a unique subjective information, such attitude and opinion, about their own health.

This concept of great importance, especially when it comes to the study of the health status of the population and the degree of utilization of certain aspects of health protection. Functional status of the elderly, Ill and disabled people must be seen as a set of integrated biological, psychological, hierarchical regional capabilities in order to secure the various activities needed to ensure individual well-being and quality of life in health care should pay more attention. Therefore this concept multidimensional approach to the statutory health status of the population oriented towards the man in all his dimensions of health, i.e. to his state of health physically and mentally, social and economic conditions of which depends on his health, its functional abilities, and when a quality of life for the availability, capabilities and degree of use of certain forms of health care. It is necessary to emphasize that the evaluation of health status, needs and demands of the population is not carried out only in the light of the above dimensions of health, but also by other population characteristics especially perceiving and demographic changes in the population.

6.2 Ecological – Epidemiological concept

In the study of his social status has a special role determining the health status of the population, depending on the interaction of many factors in the known ecological triangle: the cause – human – environment. In fact, epidemiology, as medical ecology, involves determining factors relevant to the incidence (new cases) and prevalence (existing cases) disease. Determination of health conditions as a result of the interaction of many factors in the ecological triangle (as in before pathogenesis and pathogenesis) and expressed morbidity rate, mortality and disability as healthy person actually is the result of a dynamic equilibrium. This concept Leavell’s and Clark of outmost importance in the evaluation of health status of the population.

6.3 Consequences of Disease

In reality, the high representation of chronic diseases and an increase in the number of old and of an old population show high prevalence and consequences diseases. World Health Organization is defined as the consequences: disorders, disability, limited function, handicap.

6.4 Concept of Risk Factors

Epidemiological studies have identified certain factors (risk factors) that were significantly associated with the development of certain diseases or health disorders. The Health Monitoring determine the level and trends in the prevalence of risk factors is of particular importance for a better understanding of the etiopathogenesis and prevention.

7 Conclusion

Making changes and appropriate measuring instruments for evaluating the health status of the major role in the evaluation and monitoring of these phenomena. Determination of risk factors and their association between the emergence of disease and other phenomena is of great importance not only for better understanding of the etiopathogenesis already determined the factors that should act preventively. The concept of risk factors form the basis of population and individual approach to improving health of the population. Health concepts presented together an epidemiological and socio-medical approach provides the basis for monitoring and evaluation health condition . In this context Public health – Social medicine and Epidemiology is understood in its three meanings:

- As a science of studying and synonymous with the natural flow of the disease;
- Method – epidemiological analysis and;
- As a method of establishing the essential factors for the occurrence of disease and other phenomena health disorders.

The above considerations form the basis of the approach to evaluation and monitoring of health condition – the need and demand for health care of the population in almost every region or country in a world.

References


Experience with Design of a Smartwatch Diabetes Diary Application

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Abstract

Using a smartwatch can facilitate a lot of everyday activities. In this project we focused on people with diabetes and we have designed a diabetes application for the Pebble smartwatch, which communicates with an existing smartphone diabetes diary. The original design of the smartwatch application had to be updated based on results of conducted pilot study. Patients’ feedback also served for a development of support materials such as demonstration videos and user manuals. Currently, the smartwatch application is available to the public and we are looking at possibilities for its further improvement while integrating with a next version of Pebble smartwatch, Pebble Time.

Keywords

Smartwatch, Diabetes Self-Management, Pebble, Blood Glucose

Introduction

Smartwatches is a form of wearable technologies that have been studied for a relatively long time, however without any massive expansion. Recent advances have led to development of consumer products, which are able to interact with a currently widespread piece of technology, smartphones. Co-existence of these two devices can be effectively used in various kinds of settings. We focused on people living with diabetes, who, we believe, can profit from a synergic effect of a smartwatch when using a digital diabetes diary on their phones.

Pebble is a pioneer in the area of smartwatch technology. Its successful crowdfunding-based project [1] delivered a sensor-equipped, world-wide available smartwatch. At the first glance, the Pebble watch does not significantly differ from other ordinary digital watches. However, under the hood of it, there is a computing environment with the ability to communicate wirelessly with smartphones. Besides integrated accelerometer and magnetometer sensors, Pebble also has a vibration motor, which is commonly used to intensify notifications sent to a user.

The increasing number of applications available on the Pebble App Store, their main application distribution channel, has shown the potential of such a wearable platform. The substantial amount of published applications that work with already existing smartphone companions have shown to improve the overall usability of such system due to easier access and simplicity using a wrist-worn device.

For people with diabetes, who already have adopted using a digital diabetes diary on their smartphone, the smartwatch technology can offer attractive benefits for better management of their disease. More specifically, it can offer quick access to frequently used functions of the digital diabetes diary and a longer battery life.

In terms of usability and design, thanks to several years’ experience with a smartphone applications develop-
opment, there are multiple well established user interfaces design patterns and testing practices. For wearable devices and specifically smartwatches, as a relatively new player on a market, there is not such experience-based knowledge yet. Therefore, design and development of wearable applications can be a challenging task at this early stage. In this study we aimed to develop a diabetes Pebble smartwatch application, which co-operates with the existing mobile phone-based application Diabetes Diary [2]. Aspects of the application design and results of the consequential study have been published in detail in our article in the Journal of Diabetes Science and Technology [3]. This paper describes our experience after releasing the Pebble smartwatch app to the public and also ways how we support its use.

1 Methods

We implemented the majority of currently available features of the Pebble smartwatch app within a 9 months’ timeframe in multiple iterations using agile software development methods [4]. During all testing phases, two users were involved to provide direct feedback on usability of the application and to evaluate precision of the implemented pedometer algorithm.

The main screen of the application shows latest registration for each of 3 types (BG, insulin and carbohydrates) inserted either in the Diabetes Diary on the phone or using our smartwatch application. If needed, a user can also view second latest registrations (Figure 1 – D). It is possible to use the application to insert a new registration using buttons on the side of the smartwatch (Figure 1 – A, B, C). New registrations are directly transmitted and saved to the Diabetes Diary application running on a wirelessly connected phone. In a situation when a phone is not connected while a new registration is being inserted, this registration is stored in the Pebble’s memory and sent after a reconnection.

Built-in memory of the Pebble watch is capable to store 1 year of user data (considering an average of 28 registrations per day and including 6 hours of physical activity data) when being used without a phone.

Integrated accelerometer sensor is used to estimate the number of daily steps, which is continuously updated on the main screen of the smartwatch application. A built-in algorithm of the smartphone application is then used to automatically extract individual segments of physical activity. Extracted physical activity segments, identified by a start time and duration, can be found in the registrations list view of the smartphone application.

Besides the automatic segmentation and import of physical activities (Figure 1 – E), it is possible to use a predefined dictionary to record a new physical activity and to precisely annotate its beginning and end.

We have also implemented a feature which reminds user for an upcoming BG measurement (Figure 1 – F). Reminders are shown on the display of the watch and accompanied by its vibration after 90 minutes from the last carbohydrates registration.

Due to the limited size and the possible reduced usability of the smartwatch interface, some configuration options of the smartwatch application can be managed via a dedicated application screen on the smartphone. The user has the possibility to change order of registrations screens, tune sensitivity of pedometer algorithm and alter the BG reminder time interval. Configurability options however were not included in the version of the application which was used in the study.

After finishing the prototype of the application, we recruited 6 patients (3 from Norway, 3 from Czech Republic) all having type 1 diabetes for the pilot study. The relatively small number of study participants was chosen due to the innovative character of the system. Patients were given the Diabetes Diary application for Pebble for a 1 month of testing. They were asked to fill in 2 questionnaires – before and after the test.

2 Results

On the basis of the study results we were able to incorporate particular changes before the application was released to the public. As mentioned in the Methods section, some previously predefined properties of the application were made configurable. Also, based on users’ feedback, we created support materials as a user manual and example usage videos.

Videos proved to be an effective way to explain and demonstrate the functionalities of the application. We used video length of 30 to 90 seconds, which was enough to cover a practical demonstration of a single functionality with an audio commentary. All of the videos are currently published on a YouTube channel (http://www.youtube.com/telemed) and can be used along with the user manual to get familiar with the application.

Currently, the smartwatch application is available worldwide on the Pebble App Store. Even though the smartphone Diabetes Diary application is currently available only in Norway, we have prepared the smartwatch application for its use in countries which measure blood glucose in mg/dL units as well as in mmol/l. When installing the smartwatch application in such countries, the application automatically switches the BG unit at the time of installation. This setting can be changed back again if needed from the Diabetes Diary smartphone application.

For users, it is possible to use support via email in case of need for resolving technical problems. However, we have experienced only few requests for technical help so far.

3 Discussion

The main goal was to design, develop and evaluate usability of a diabetes smartwatch application. Bidirectional
synchronization with an existing mobile phone diabetes diary was considered as necessary, primary feature for the application. Upon its successful implementation we integrated and tested other previously described features in multiple iterations.

In a non-formal part of a study, during dialogs with patients, we have experienced an increased motivation to use the system due to a quickness of making new registrations using the Pebble watch. These non-formal meetings were arranged for an on-site installation of the application and occasional support and troubleshooting.

At the time of application release, Pebble was the only smartwatch with its own market place, similar to those which are used for smartphone applications distribution. This fact contributed to a smooth distribution of the application when the study was over. Recently, Pebble has announced a new, improved version of their smartwatch, Pebble Time. Apart from a color display and software updates, Pebble Time will also offer a bigger size of memory. Therefore, it will be possible to expand a functionality of the application. Besides that, we can expect more devices, which will include more sensors or which will include more input options, coming to the market. One of the examples is the Apple Watch introduced by Apple Inc., which is, however, known to work with iOS-based devices only.

Utilization of an open platform, such as the Pebble watch, significantly facilitates its integration with existing applications on different mobile platforms. Our future work will aim to include and investigate use of more wearable devices within our diabetes portfolio.

Acknowledgements

The study was supported by Centre for Research-based Innovation – Tromso Telemedicine Lab. (TTL), Norwegian Research Council Grant No.174934 and partially by the project SVV 260158 of Charles University in Prague. A big thanks go to the test-users who agreed to test this new concept and technology and give valuable feedback, the software developer team at NST, the Diabetes team at the Division of Internal Medicine, University Hospital of North Norway, and MUDr. Jan Broz, Department of Internal Medicine, Motol University Hospital, Prague, for helping with obtaining testers in Czech.

References

Home Blood Pressure Monitoring

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Abstract

The current European Society of Hypertension Practice Guidelines for home blood pressure monitoring (HBPM) contain a standardized BP logbook. The aim of this presentation is both to make the use of this logbook in practice easier and add other useful properties: an easy calculation of the average systolic and diastolic BP from several monitoring days, but also that of the morning and evening mean BP as well; differently coloured cells for extreme both high and low BP and heart rate levels; a calculation of average of 3 BP readings in case of their bigger difference and a HBP indirect telemonitoring.

Keywords

Home blood pressure monitoring, BP logbook in Excel form, home BP telemonitoring

1 Introduction

Office blood pressure (BP) is usually higher than BP measured out of the office, which has been ascribed to the alerting response and anxiety. Moreover, out-of-office BP commonly assessed by 24-h ambulatory BP monitoring (ABPM) or home BP monitoring (HBPM), usually by self-measurement provides a large number of BP measurements, which represents a more reliable assessment of actual BP than office BP and consequently gives a more precise diagnostic evaluation and titration of antihypertensive medication and a better prediction of cardiovascular morbidity and mortality.

2 Methods

Automated recording of multiple BP readings in the office with the patient seated in an isolated room might be considered as a means to improve reproducibility and make office BP values closer to those provided by daytime ABPM or HBPM [1]. The main problem for its wider use is finding a free room in a hypertension clinic and a prolongation of a hypertensive patient’s visit with consequent organisational difficulties.

ABPM is currently considered the reference for out-of-office BP. The procedure should be adequately explained to the patient, with verbal and written instructions; in addition, self-measurement of BP requires appropriate training under medical supervision [1]. HBPM is cheaper, more widely available and more easily repeatable. The results are to be reported immediately after each measurement in a standardized logbook structured according to the required monitoring schedule that is useful for ensuring the accuracy of data reporting and for improving adherence to measurements schedule [2]. However, BP values reported by the patient may not always be reliable. The ways to overcome this obstacle are being still subjects of research.

3 Results and Discussion

As it was presented earlier, the logbook was transferred to Excel which enables an easy calculation of the average systolic and diastolic BP from several monitoring days, but also that of the morning and evening mean BP as well. This offers additional information for better BP control leading to a change in dosage from once to twice daily in some cases.

The Excel logbook version presented in 2012 European Hypertension Meeting in London introduces differently coloured cells for extreme both high and low BP and heart rate levels for a quick information of both a patient and physician as well as increased BP mean.

The current Excel BP logbook version (Figure 1) has a special colour for the suitable BP mean range, especially of treated hypertensives. To increase the accuracy of BP measurements the electronic logbook shows bigger differences between BP readings per occasion - ≥ 10 mmHg for systolic BP and/or ≥ 5 mmHg for diastolic BP and of-
fers the third measurement to a user in such a case. It is a matter of a personal choice of two values nearer one to another from three measurements. Alternatively, the logbook calculates an average of 3 BP readings.

Looking at results stored in a memory-equipped device is time consuming and therefore not generally accepted by GPs.

In order to support patients’ interest in the diagnosis and management of their hypertension and improve their knowledge under the conditions mentioned above the leaflets with a direct link to the Excel BP logbook and basic instructions for HBPM on www.celimed.cz are to be enclosed in boxes with both new and repaired OMRON devices.

Patients with basic IT knowledge can e-mail the fulfilled Excel logbook and physicians can adjust medications according to reported BP values and thus usually reduce the number of visits or schedule an additional office visit. It can be saved in a patient’s electronic record.

Home BP telemonitoring was shown to improve hypertension control in general practice [3]. In contrast, the proposed indirect telemonitoring has no additional costs (for mobile telephone operators) and acceptable reliability of BP values.

4 Conclusion

The HBPM electronic logbook in the Excel form can contribute to a greater involvement of the patient in the therapy of his/her disease and increase GPs’ effectiveness due to the structured ready results and evaluation in a printed or electronic form given by a patient at visit, sometimes also due to the cheap and accessible HBP telemonitoring and thus for improving hypertension control in population.

References


DNA analysis has experienced rapid development in recent years. It is used not only in criminalistics in identifying the perpetrator or in paternity testing, but also in archeogenetics, genealogy or in identifying victims of mass disasters. Lately, it is used increasingly also in medical testing.

For people with Huntington’s chorea, analysis of trinucleotid repetitions is carried out, since their expansion increases the probability of an unbalanced psychological condition and it can affect the court’s decision in assessing the offender’s sanity and his self-control.

Analysis of selected mutations in donors of oocytes or sperms is used to prevent certain genetic diseases; e.g. factor V Leiden results in genetic predisposition to thrombosis. For people with certain psychological disorders (manic depression, schizophrenia, Alzheimer’s disease, epilepsy) may be genetically determined response to medication. E.g. for warfarin are clinically significant two of the 24 known alleles VKORC 1, which enhance anticoagulant effect of warfarin and thus reduce the daily dose needed to maintain the INR (International Normalized Ratio) in the therapeutic range.

Because of possible legal consequences of inappropriate treatment is sometimes performed predictive analysis of mutations in susceptibility or resistance to drugs. E.g. for carriers of allele 28 in the gene UGT1A1 is observed severe toxicity on Irinotecan, whose effectiveness has been clinically tested in many tumors. A predictive test is therefore important for the doctor before starting treatment.

Thanks to many well-known media outputs, DNA analysis is considered to be an absolutely reliable process, but this conviction is not based on realistic foundations. Increasing sensitivity of methods of forensic analysis allows to investigate diminishing amount of biological material. With this development do not keep up legislation (attending obtaining DNA samples, their application and subsequent retention in DNA databases) or mathematical methods. Even for commonly used methods, detailed derivation rarely exists; very often unambiguously accepted definitions of terms used is absent, which can lead to erroneous interpretations and biased or even completely meaningless results [1]. Current approaches, unfortunately, can lead to very different match statistics on the same DNA data [2] and development in this field therefore aims to standardize the methods used.

Acknowledgements

This paper has been partially supported by the SVV-2015-260158 project of Charles University in Prague.

References


Occupational Health Risk and Health Impact Assessment: Necessary Information Facilitating Correct Medical Fitness Assessment for Work

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Abstract

Framework Directive on Health and Safety at Work 89/391/EEC is concentrated on three main issues: the risk evaluation, the protective and preventive services and the consultation and participation of workers. Protective and preventive services called occupational health services (OHSs) should be represented by multidisciplinary expert team; medical part of this service is realized by occupational medical service (OMS) providers. One of the crucial medicolegal activity of occupational medical service providers is the certification of medical fitness for work issued by examining physician and based on knowledge of working conditions/health risks at work and on results of occupational medical examinations of workers/employees. Working conditions are generally assessed by specific health risk assessment (so called System of categorization of work operations) established in the Czech Republic on monitoring 13 harmful factors in the workplace. Working operations are divided into four categories: category 1 is the safest, category 4 is the worst according to the extent of risk. The prediction of occupational disease (OD) in correlation to the risk category based on number of persons working in risk categories is 5/100.000 in risk category 1 (12.3 % of OD), 1/10.000 in risk category 2 (24.7% of OD), 9/10.000 in risk category 3 (46.6% of OD) and 9/1000 in risk category 4 (12.0% od OD).

Keywords

Occupational exposure; risk factors; health risk; occupational health services; fitness assessment for work

1 Introduction

Framework Directive on Health and Safety at Work 89/391/EEC is concentrated on three main issues: the risk evaluation, the protective and preventive services and the consultation and participation of workers.
cold exposure, psychological burden, visual burden, biological agents, high air pressure).

There is sometimes negative health impact of working conditions (occupational injury and occupational disease). An occupational disease (OD) is defined in the Czech Republic as a disease caused by the noxious effects of chemical, physical, biological, and other factors, provided that the disease originated under conditions described in the List of Occupational Diseases.

Protective and preventive services called occupational health services (OHSs) should be represented by multidisciplinary expert team; medical part of this service is realized by occupational medical service (OMS) providers. One of the crucial medi-colegal activity of occupational medical service providers is the certification of medical fitness for work issued by examining physician and based on knowledge of working conditions/health risks at work and on results of occupational medical examinations of workers/employees. Combination of relevant information from practical risk assessment in the workplace with information from surveillance of worker’s health is very important for correct medical fitness assessment.

2 Materials/methods

Author analyzed impact of the Czech health care legislation (incl. new reform in 2012) in the field of occupational medical/health services on the working population (at about 5 million people working in more than 74,000 subjects/enterprises). As a tool for health risk assessment a system of categorization of working operations has been established in the Czech Republic. The system is based on monitoring of different harmful factors in the workplace. Working operations are divided into four categories (category 1 is the safest, category 4 is the worst) according to the extent of risk. The available data about the number of persons working in different risk categories in comparison with number of occupational diseases associated with work in these categories were used for prediction of occupational diseases according to the risk category.

3 Results

Relevant numbers of persons working in certain risk categories are: 14,801 persons in category 4 (0.3%), 479,182 persons in category 3 (9.8%), 1,880,153 persons in category 2 (38.4%) and 2,519,847 persons in category 1 (51.5%). Numbers of recognized occupational diseases (1099 in 2012) associated with working conditions in certain risk category of work are: 132 cases from category 4, 512 cases from category 3, 271 cases from category 2, 136 cases from category 1 (14 cases not classifiable according to category). The prediction of occupational disease in correlation to the number of persons working in risk categories is 5/100,000 in risk category 1 (12.3% of OD), 1/10,000 in risk category 2 (24.7% of OD), 9/10,000 in risk category 3 (46.6% of OD) and 9/1000 in risk category 4 (12.0% of OD) (for 4.4% of OD are data about risk category not available).

4 Discussion

Protective and preventive services called occupational health services (OHSs) should be represented by multidisciplinary expert team; medical part of this service is realized by occupational medical service (OMS) providers. The provider of OMS is required

- to inform employee about the possible influence of factors of working conditions on his/her health, and with knowledge of the development of his/her state of health,
- to inform employers about the possible influence of factors of working conditions on the health of employees,
- to perform periodic monitoring of the workplace conditions,
- to cooperate with the employer, employee, safety and health at work specialist, governmental inspection authorities and trade unions,
- to notify promptly the employer of serious or repeated facts adversely affecting health and safety at work,
- through employer to ensure the measurement/expertise and analysis of the working conditions, working environment including the results of categorization of health risks.

General description of the factors load level (risk categories 1–4):

1. Grade of load – category 1 – minimal health risk – factor is not existent in the work environment or the load is minimal, optimal working conditions (minimal health risk even for handicapped persons, influence of factor is irrelevant from the health point of view)

2. Grade of load – category 2 – acceptable level of health risk – from the health point of view is level of load caused by factor acceptable, exceeding of load limits as per regulations doesn’t exist (the influence of factor for healthy person is acceptable but negative effect of factor can’t be excluded for sensitive individuals)

3. Grade of load – category 3 – considerable level of health risk – the level of factor load is exceed- ing given exposure limits, there are necessary re-alisations of technical replacements and organisational regulations at workplaces (negative influence on health of workers can’t be excluded)
4. Grade of load – category 4 - high level of health risk – the level of factor load is highly exceeding given exposure limits, complex of preventive regulations must be observed (occupational diseases are more often present)

Special guidelines for assessment of various types of occupational health risks are available. The category of the work operation and the most important risk factor determine the frequency and range of periodic medical examination of workers and frequency of periodic measurements of different harmful factors at workplaces. Some occupations (drivers, railway workers, firemen etc.) have besides the examinations described above special content of preventive occupational medical examinations.

Occupational medical examinations of individuals (workers and employees) are initial/entry, periodic, extraordinary, output and consequential. A keystone of quality performance by an examining physician is the familiarity with specific working conditions and demands of the respective job and the knowledge of the state of health of individual workers. Correct medical fitness assessment for work is crucial from medical point of view for prevention of negative health impact. Conclusions of certificates of medical fitness assessments for work are: medically fit, medically fit with certain condition/medical restriction (related to the concrete technology, type of production or service and individual health status - mainly allergy in medical history, impaired vision, sometimes impaired hearing, metabolic, cardiovascular or neurological diseases), medically unfit for work (relatively rare).

Percentage of workers covered by occupational physicians’ surveillance (coverage) is about 72.5 % (13.6 of occupational full-/part-time physicians per 100,000 workers). There are in principle two types of OMS providers in reference to the level of their medical training:

1. occupational physicians specialized in occupational medicine (recognized/certified occupational physicians), and
2. non-specialists in occupational medicine, usually general practitioners (some of them with short training in occupational medicine: company/factory physicians).

5 Conclusions

One of the crucial medicolegal activity of occupational medical service providers is the certification of medical fitness for work issued by examining physician and based on knowledge of working conditions/health risks at work and on results of occupational medical examinations of workers/employees. The simplified approach when only health examinations of workers without any other important activities (such as workplace visits, risk assessment, consultations for employers and employees etc.) are realized, may have serious consequences, particularly in incorrect medical fitness assessment for work especially for vulnerable workers (i.e. pregnant women, older workers), which can lead to the negative impact on occupational health and can influence the working culture in enterprises. The prediction of occupational disease in correlation to the risk category based on number of persons working in risk categories is important for general perception of risks and decision making about the relevant coverage of working population by occupational health/medical services.

Acknowledgements

Supported by scientific program PRVOUK P25/LF1/2 of Charles University in Prague, Czech Republic.

References

Online Telemonitoring System of Diabetes – Supervision and Management of Patient Treatment for Type 1 Diabetes Mellitus

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Abstract

Background: The amount of carbohydrate intake, injected insulin dose and the level of physical activity are the most significant factors which have an influence on the metabolic compensation of the type 1 diabetes. These parameters can be measured by many technical tools. However, there is a problem with assessment of the enormous amount of data and its heterogeneity.

Objectives: The goal is to make a technical solution for data collection, sharing and centralization of measured parameters of each patient. This involves giving transparent and assorted information which allows quick and useful consultations.

Methods: The telemedicine system integrates the three technologies for gathering the main parameters – glucometer, activity tracker and smartphone application. The system allows online transmission of measured data to a web server where they are integrated for individual patients and sorted out for potential evaluation by health care personnel.

Results: The verification of the telemonitoring system has been done through a pilot study. System successfully worked for the majority of participants. The unsuccessful cases were caused by easily correctable errors.

Conclusions: The tested telemonitoring system allows real-time data sharing of patient-gathered data with their doctor. It enables to trace the various trends of measured quantity and consequential statistical processing. The system can potentially improve the decision in treatment modifications.

Keywords

Telemedicine, Diabetes Mellitus, Mobile Applications, Glucometer, Activity Tracker

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Introduction

Telemonitoring is more and more common tool in therapies for metabolic diseases. It can have a positive effect on improving of patients’ health and increase the quality of medical care, and in addition it has the potential of reducing the need of using the health services. It can also reduce treatment expenses. A stable and positive health status for the patients often improves their overall satisfaction and standard of living. An important aspect of telemonitoring is increasing patients’ knowledge and education regarding the impact and progress of their illness [1] [2]. Patients are often motivated to be more interested in their disease [3].

Diabetes mellitus is a group of metabolic diseases characterized by high glucose levels in the blood resulting from defects in insulin secretion, insulin action, or both. Many factors have an influence on the metabolic compensation of the type 1 diabetes. The most significant is the amount of carbohydrate intake, injected insulin dose and the level of physical activity [4]. These parameters can be measured and supervised by many technical tools...
available in the market. Thanks to these tools we can get more information and more useful data. However, there is a problem with assessment of the enormous amount of data and its heterogeneity. Another challenge is how to motivate the patient enough to measuring these parameters, as it is painful, discomfort, technically demanding and time consuming and patients may have insufficient education to self-management.

Objectives

The main goal of this project is to make a technical solution for data collection, sharing and centralization of measured parameters of each patient. This involves giving both the patient and the health care personnel transparent and assorted information which allows quick and useful consultations. The benefits for the patients are direct feedback and better supervision of their disease, with the basis in their current life style and its effect on the disease, and possibly increased patient motivation to adhere to treatment respectively. A direct and quick supervision of the patient is a benefit which might give the doctor more time to adjust the treatment. The telemonitoring system can prevent or decreases negative impact of diabetes mellitus on the patients (hypoglycemic events due to low levels of blood glucose and comorbidities caused by inadequate compensations of high blood glucose levels). Reduction of the disease’s negative effects might lead to cost reductions in treatment and increasing quality of patient life.

Methods

The telemedicine system (Figure 1) integrates the three basic commonly available technologies for gathering the main parameters - glucometer for measuring blood glucose level (Mini Diamond from the manufacturer ForaCare Inc.) activity tracker for monitoring of physical activity (Flex from the manufacturer Fitbit Inc.) and a smartphone application called Diabetesdagboka (Diabetes Diary) which allows recording of carbohydrate intake, blood glucose values, physical activity and insulin doses (developed in collaboration of The Joint Department of Bio-medical Engineering at CTU and Charles University in Prague with the University Hospital of North Norway, Norwegian Centre for Integrated Care and Telemedicine). Information about the carbohydrate intake and insulin dose is needed to be entered manually to the application. Each device automatically uploads information about measured blood glucose levels and level of physical activity into the mobile application.

The system also allows online transmission of measured data to a web server where they are integrated for individual patients and sorted out for potential evaluation by health care personnel (Figure 2). The system displays the timeline with records of physical activity, blood glucose
Obrázek 2: The online transmission of measured data to a web server.

levels, carbohydrate intake and insulin doses. It allows
monitors trends in blood glucose levels and dependency
rate of glucose level on physical activity. Simultaneously
the doctor can perform statistical comparisons of measu-
red values. All data are protected according to the current
legal legislation. The measured data are held on the ser-
ver. Which means they are not sent to a doctor, hence no
advices are given to the patient. The telemedicine system
also allows later data synchronization with the continuous
monitoring system (Guardian REAL-Time from the ma-
ufacturer Medtronic Inc.) records. Smart watches (Smart
Pebble watch manufacturer Pebble Technology Corp.) are
part of that system. They can upload data to the Diabete-
sdagboka application directly from the device located on
user’s wrist, and it is two-ways communication between
the smart phone and Pebble watch.

Results

The verification of the telemonitoring system has been
done through a study where forty–two patients were invol-
volved – twenty–four women and eighteen men. The median
test–period was seven days. Results from thirty–five pati-
ent were successfully uploaded to the system and post–
processed (from 21 women and 14 men), while for seven
cases this was not successful. Data weren’t shared from
activity tracker in four cases and the sensor of continuous
monitoring system fell out of the patient body in three
cases. Not all patients used all functions of Diabetesdag-
boka as it wasn’t necessary for the basic verification of the
system functionality. The patients evaluated the system as
easy to use and user–friendly [5]. The procedures have been
in compliance with the ethical standards of the committee
on human experimentation and with the World Medical
Association Declaration of Helsinki on Ethical Principles
for Medical Research Involving Human Subjects.

Conclusion

The tested telemonitoring system allows real–time data
sharing of patient–gathered data with their doctor. The
doctor can assess the success of treatment. If needed,
the doctor can call in the patient for check–up and ad-
just her treatment in order to prevent the comorbidities.
The system provides easily accessible and timely infor-
mation about current patient health. It enables to trace
the various trends of measured quantity and consequential
statistical processing. The system’s reliability was tested
in a pilot study which successfully worked for the major-
ity of participants. The unsuccessful cases were caused
by easily correctable errors. Hence the system can be a
reliable technical tool for doctors and patients to provide
data for potential improved decision in treatment modifi-
cations.
Acknowledgements

This work was supported by the project SVV 2015 c. 260158.

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Electronic Oral Health Record Enriched by Structured Information from Narrative Medical Reports

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Electronic health documentation is often the key to better decision making and quality assurance tasks. New requirements to collect data in healthcare are based on electronic health record, where information is stored in a structured form. Structured representation of information in electronic health record is important for reuse of information in medical decision support, statistical analysis of data, interoperability issues and automatic speech recognition. The new model of the structured electronic oral health record for dentistry with the lifetime interactive DentCross component focused on multilingual applications in dental care was developed [1]. Figure 1 shows the German version of Lifetime DentCross. Here by the combination of crown denture and pontics we can build bridges from the available components and simultaneously mark a material composition. System offers a selection of crown casing, veneered and combined as appropriate bridge.

Design of an Electronic Oral Health Record (EOHR) was proposed in such a way that both narrative medical reports and coded data can be stored simultaneously. Moreover, from a narrative medical report some structured information can be extracted and embedded to EOHR.

Structured information is becoming increasingly important in almost any data processing. In medicine narrative medical reports can be eliminated only to some extent, but it is not generally possible to suppress them completely. The big advantage is to be able to extract further structured information from narrative medical reports.

Acknowledgements

The research on EOHR with structured information and narrative medical reports was supported by the projects P28LF1/6, P29/LF2 and SVV 260158.

References

National Health Registries in the Czech Republic as Unique Data Source for Planning and Evaluating Health Prevention Programs

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Abstract
Population registries are very valuable data sources for epidemiology analyses and preventive program planning, monitoring and evaluating. Czech Republic has a system of National health registries that covers information about serious diseases. Analytical publications are issued using these data sources, but possibilities offered by these sources are much wider.

Keywords
Prevention, Epidemiology, Mortality, Morbidity, Registries

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The Czech Republic has a relatively extensive system of National health registers. These registers collect important information about the incidence of serious diseases in the population. Reporting to National health registers is obligatory by law.

National health registers collect information about cancer (Czech National Cancer Registry), cardiovascular diseases (National Register of Cardiovascular Surgery and Interventions), reproductive health (National Register of Reproduction Health), mental health (National Register of Therapy of Drug Users), traumatology and orthopaedics (National Register of Joint Replacement, National Register of Injuries). Registry of hospital admissions (National Register of Hospitalized Patients) plays also an important role. It collects information on all cases of hospitalization in the country. The administrator of the health registers is Institute of Health Information and Statistics of the Czech Republic (IHIS CR). Mortality statistics is provided in collaboration with the Czech Statistical Office.

All above mentioned data sources can be used for many purposes including health services planning, monitoring and evaluation and for describing variations and trends in the epidemiology of serious diseases [1,2]. Data from the registers can also be used for analysis and research on risk factors, for the identification of vulnerable populations, and for targeting and evaluating prevention programs [3,4,5,6].

Recent analyses focus on chronic non-communicable diseases. Data from the Czech National Cancer Registry is used for analyses and predictions of the Czech Society for Oncology and Masaryk University in Brno. Other analyses [7,8,9] made in cooperation with other professional societies create informational support for cancer screening programs (Breast Cancer Screening, Cervical Cancer Screening, and Colorectal Cancer Screening Programme). IHIS CR published detailed topical analyses of available population based data about myocardial infarction and cerebrovascular diseases [10,11]. Still epidemiological analyses for many diseases have not been compiled.

National health registers in the administration of IHIS CR are presented on the website www.uzis.cz. Their data are published in the regular publications on various topics that are posted at the same place. Data from the registries are aggregated into publications and summaries about the health status of the Czech population and about the health care system in the Czech Republic [12]. Data outputs from national health registers are forwarded to international organizations dealing with health statistics (WHO, OECD, EUROSTAT) and international research projects as CONCORD Study [13].
Maintaining and developing population-based health registers is a prerequisite for obtaining high-quality data for epidemiological analysis and health statistics. Datasets of these registers are stable structures for obligatory reporting. They can act as a basic components for structured patient’s health records in the hospital information systems.

Acknowledgements

The work has been partially supported by the project SVV 260 158 of Charles University in Prague.

References


