TRENDS IN ICT DEVELOPMENT FOR FURTHERING THE MANAGEMENT
OF IN ABSENTIA HEALTHCARE SPATIAL INFORMATION

MARTA R. JABŁOŃSKA, KAROL KORCZAK

Summary

The role of fast diagnostics and effective prophylaxis, based on ICT, may be crucial in future healthcare. That is why, the authors of the paper, have conducted a comparative analysis on Polish in absentia healthcare market. The aim of the paper is an analysis of actual trends of in absentia healthcare solutions that could be supported by GIS and identification of problems that may be associated with their implementation.

Keywords: managed care, healthcare, medicine, analysis of healthcare markets

Introduction

Nowadays there are many new ICT\(^1\) solutions, devices and gadgets that are used to monitor different aspects of our health. In the literature they may be associated with terms such as: e-Health, telemedicine, mobile medicine and cybermedicine. And what is important, more and more of them use the Internet as a medium for communication and exchange of information. It is a clear announcement of upcoming changes in the approach to providing healthcare services. In absentia healthcare (without personal contact with a doctor, also known as distance medicine) is developing in new directions.

Integration of new ICT solutions and medical information systems may develop a quality of in absentia healthcare. Among three potential barriers of successful e-health systems dissemination there are: narrow focus on technological aspects, too little involvement from key stakeholders and lack of a good underlying business model [13]. The first issue can be aided by ICT technologies to improve healthcare in absentia systems development. Sensors, implants and mobile devices (such as smartphones or tablets) can contribute to shortening diagnostics time, improving efficiency of treatment, providing real time monitoring of vital parameters and sending alerts if an anomalous situation occurs.

In absentia healthcare solutions can be applied in countries with wide geographic dispersal of inhabitants, in areas with a deficit of medical service but also for patients that need to be taken under observation for 24-hours a day or for elder people. However, it is crucial to remember that e-health systems evaluation may vary due to local infrastructure, habits or culture at a given point in time [26]. Nevertheless, independently from reason of applying ICT and geographical localization of planned system, there is a reference to geographic data presence. That is where Geographical Information Systems\(^2\) come in handy. They can be defined as systems composed of hardware, software, people and infrastructure capable of data capturing, storage, inquiry, analysis, displaying and defining spatial relationships of geospatial data differentiating it from other ICT systems [14, 28]. GIS manages on raw data from direct, geographic measurements and brings new tools for e-health by taking into consideration all factors affecting the studied problem. These tools enable integration of data from numerous, different and dispersed sources into a centralized database from which they

\(1\) Information and Communication Technologies = ICT.
\(2\) Geographical Information Systems = GIS.
can be analyzed [18]. In other words, among its functionalities there are operations such as data acquisition, processing, verification, integration, manipulation, analysis and presentation. All of them may be used to improve quality of in absentia healthcare.

Spatial data includes two basic components, namely: location and attribute of the feature [25]. In GIS these data is gathered into a set called ‘coverage’ and stored in database. Medical information data, such as diagnosis, vital parameters, prescriptions, description of the diseases, pharmaceuticals, etc. is gathered simultaneously with geographical data including spatial dispersion and localization, or demographic information. Thanks to these geographical aspects, it becomes crucial to introduce GIS to analyze medical data spatially. With GIS intrusion, medical systems may be supported with a spatial analysis by adding information about location, overlaps, proximities, zones of influence, scale or distances and improving quality of decision-making process [11].

The aim of the paper is an analysis of actual trends of in absentia healthcare solutions that could be supported by GIS and identification of problems that may be associated with their implementation. For this purpose a review of selected Polish in absentia healthcare initiatives (national, regional and local ones) was conducted.

The structure of the paper is organized into four sections as follows. The second one is dedicated to application of ICT aided by GIS in healthcare. Range, assumptions and results of comparative analysis of selected initiatives are presented in the third section. The aim of the fourth one is to outline the research problems and describe some remarks on possible future in absentia healthcare trends. The last section is a closure with conclusions and possible discussion issues.

1. ICT applications aided by GIS in healthcare

Nowadays information and communication technologies are very important factor influencing efficiency growth of numerous economic and social sectors. ICT make easier and faster access to information, data exchange, communication or realization of services. One of such area is undoubtedly health sector. In Poland, we can find healthcare facilities offering ICT tools that manage a variety of spatial information. In this context, we should mention tools that support:

- health monitoring,
- access to the results of medical examinations,
- access to medical records,
- consultation with a doctor / nurse,
- ordering a home visit,
- e-Prescription,
- e-Referral,
- e-Commission,
- exchange data with other units,
- advising in health promotion.

Implementation of such tools is now regarded as one of the main actions at all levels of management in healthcare. Because of growing number of Internet users such changes seem to be sensible. Nevertheless, we have to remember that introducing information and communication technologies to health sector might be very complicated process. It requires buying computer hardware to health-care facilities, writing software based on data bases and warehouses, introducing standards of electronic data interchange and interoperability, professional training and many others. In spite of many real difficulties, putting new ideas into practice is very important and it may have significant
influence on effectiveness of patient service [29, 30]. In Poland examples of ‘good practices’ we can find mainly in nonpublic and private health service facilities. These institutions are still improving quality of their services. Moreover, lately we can observe some interesting regional and national initiatives3. Analysis of e-health solutions (such as those listed above) shows directly that each of them proceeds spatial, geographical data at some point. That is why described ICT technologies should cooperate with GIS systems to develop existing and emerging e-health services.

The important role that GIS systems play in nowadays healthcare is widely seen in current literature all around the world. In [31] it is pointed that GIS system usage in public health is currently limited to tracking immunizations, disease surveillance, and establishing new service areas. Yet, it has potential to improve planning, implementation and monitoring of health services. What is more, GIS overlays for healthcare resource and environmental information [4] as well as provides useful insights into environmental, economic, political and social determinants of public health [5]. In other words, GIS systems may play a crucial role for public health managers [15].

Due to [9], GIS systems in Healthcare may be used to determine spatial correlates of health, to support the evacuation of injured people, monitoring the spread of infectious diseases, gathering data for statistical analysis of the effect of pollution on public health, as well as providing assistance to elderly people with orientation difficulties. Its importance for health planning and health services delivery, particularly at the local levels was mentioned also in [20].

Pliskie and Wallenfang [21] claim that GIS is important due to the fact that it helps organizations to better understand the patient’s population features, demographic and socioeconomic trends, as well as shifts in the healthcare’s utilization. GIS systems are also important in understanding the dynamics of health, as well as the reasons why diseases are spreading [19].

Fradeles [6] underlines that medical research as well as the study of the Earth’s surface have much in common as their relationship dates from antiquity. What is more, Fradeles [6] describes that GIS systems may act as a decision making tool in the healthcare sector with the addition of contribution to policies creation in this sector. The role of GIS systems in healthcare in developing countries was described in [16], while Atiehortua-Otero [2], Rai [22] concentrates at its local range and influence and Hawthorne [10] presents GIS role in understanding the unequal geographies of healthcare in lower-income urban neighborhoods.

Cooperation of GIS and remote sensing suitable for use in infectious disease surveillance and control was presented in [22], while State Surveillance Training Program based on GIS was described in [3]. GIS implementation in applications in prescription drug use was presented in [27]. In [7] GIS applications of mobile health clinic service were characterized.

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2. Comparative analysis of selected in absentia healthcare initiatives

One of the main aims of the paper – as it was mentioned in the introduction section – is to present actual trends of in absentia healthcare solutions where the conception of GIS could be applied. These trends epitomize current situation of in absentia healthcare in Poland and review the most important initiatives, projects and companies that lead the way in e-health. In absentia healthcare is gaining more and more popularity all over the world. Nevertheless, the pace of e-health dissemination in each country differs according to differences in advances in ICT technologies intrusion, healthcare level and other aspects, such as demographic and income structure. That is why, in authors opinion, it is more justified to analyze possible trends of in absentia healthcare on a local, Polish, background. To meet this assumption, three types of e-health initiatives were taken into consideration: national, regional and local ones.

The first step of conducted research, was to make a review of selected Polish in absentia healthcare initiatives. Generally, two types of methods of organization are present among them: private companies and projects/public initiatives. To make comparative analysis more complete and relevant, both types were taken into consideration. After review of Polish e-health market sixteen subjects were selected, including 8 projects and 8 enterprises.

Next, selected subjects were analyzed in nine categories:
- geographical range,
- type of exchanged data,
- subjects exchanging data,
- category of activity,
- main aims of the activity,
- determinants of further development and dissemination,
- possibility of estimation influence on the population,
- key technologies.

Comparison, made on the basis of these categories, was used to define possible gaps and feasible methods, as well as imaginable barriers of development of ICT-aided in absentia healthcare. In the further part of this section, the results of the analysis will be presented according to the categories mentioned above.

The list of analyzed objects was presented in the table 1.
Table 1. Analyzed objects of Polish in absentia healthcare initiatives

<table>
<thead>
<tr>
<th>Polish name</th>
<th>Subject</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Sieć Zycia&quot; Lifenet</td>
<td>Physio-control</td>
<td>Pre-hospital diagnosis of coronary artery disease stringent conditions</td>
</tr>
<tr>
<td>Kardiotele</td>
<td>Telemedyceyna Polska</td>
<td>Telephone consultation with a physician and cardiac monitoring 24h/365 days a year, sending ECG via telephone, help call an ambulance</td>
</tr>
<tr>
<td>Holter EKG 24h</td>
<td>Telemedyceyna Polska</td>
<td>24-hour, automatic monitoring of heart</td>
</tr>
<tr>
<td>TeleInterMed</td>
<td>Institute of Cardiology in collaboration with the Norwegian company ExponorTromso</td>
<td>Long-term monitoring of cardiac arrhythmias</td>
</tr>
<tr>
<td>Telepatologia</td>
<td>SPT IGiChP</td>
<td>Exchange patomorphological-clinical images of respiratory diseases and chest</td>
</tr>
<tr>
<td>Nefrologin</td>
<td>Nefrologin Sp. z o.o.</td>
<td>Ambulatory monitoring of the state of hydration of the patient dialyzed with Aqua Balance</td>
</tr>
<tr>
<td>eDziecko</td>
<td>eMedicina Polska Sp. z o.o.</td>
<td>Convenience, wireless overseeing the welfare of the fetus: recording and analysis of the stock uterine contractions, fetal and the mother heart rate.</td>
</tr>
<tr>
<td>eSerce</td>
<td>eMedicina Polska Sp. z o.o.</td>
<td>eCardioMonitoring for people with high physical activity or patients with chronic coronary artery disease after cardiac incidents requiring assistance wherever it does not get care. eCardioRehabilitation - a rehabilitation program for patients at risk, after the incidents and cardiac</td>
</tr>
<tr>
<td>Videokonsultacje</td>
<td>MedGo</td>
<td>24-hour cardiac telecare, ECG, assessment of the risk of heart disease, diagnosis of heart failure</td>
</tr>
<tr>
<td>SIMPRE</td>
<td>Marshall's Office in Lodz</td>
<td>Electronic patient record</td>
</tr>
<tr>
<td>In4health</td>
<td>Marshall's Office in Lodz and selected health centers</td>
<td>Improving the quality of life of the inhabitants of the Lodz Region by providing the possibility of using a wide range of centralized health information realized by increasing public access to them electronically, and the development of practical services in the field of eHealth supported by modern information and ICT</td>
</tr>
<tr>
<td>RICHARD</td>
<td>Marshall's Office in Lodz, Pixel Technology, University of Lodz, Provincial Specialist Hospital M. Pirogow in Lodz</td>
<td>Creation of an integrated model of chronic disease management, implementation of the common model for chronic disease management</td>
</tr>
<tr>
<td>EHR-Q-TN</td>
<td>Marshall's Office in Lodz</td>
<td>Electronic patient record</td>
</tr>
<tr>
<td>Platforma P1 (IKP)</td>
<td>CSIOZ</td>
<td>Creation of solutions that enable collecting and processing of reliable data on medical events</td>
</tr>
<tr>
<td>ZIP</td>
<td>National Health Fund</td>
<td>Collection of historical data about treatment and financing of treatment</td>
</tr>
<tr>
<td>OSOZ</td>
<td>Kamsoft S.A.</td>
<td>Information system designed to support the health management</td>
</tr>
</tbody>
</table>

Source: own research.

The first category is probably the most general and basic one. Geographical range defines the array of collected spatial data as well as possible influence of analyzed solution on the population.
It can be assumed that small, local initiatives will have smaller influence and probably more barrier of further development to deal with. For the purpose of comparative analysis three types of geographical range were specified: national (whole country), regional (one or more voivodeships) and local (city, district or province). The distribution of analyzed objects was presented in the table 2.

Table 2. Geographical range

<table>
<thead>
<tr>
<th>Geographical range</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>10</td>
</tr>
<tr>
<td>Regional</td>
<td>2</td>
</tr>
<tr>
<td>Local</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
</tr>
</tbody>
</table>

Source: own research.

The most significant type of initiatives were national ones due to Internet usage. With placing offered services in the Web and implementing some ICT technologies (described in the further part of this section), national level was achieved, often with the possibility of going international.

Due to type of exchanged data, following categories may be defined: clinical data and preventive data. 14 out of 16 analyzed object exchange clinical data and only 2 preventive data. These numbers are correlated with the next category, namely subjects exchanging data. Physician and patient are the most important subjects (in this case the actors) representing this category. The communication between them can be enumerated as follows:

- patient – physician (or/and physician – patient),
- physician – physician (also in both directions),
- patient – ICT application (without contact with physician, also in both directions).

The results of analysis were put in the table 3.

Table 3. Type of communication

<table>
<thead>
<tr>
<th>Communication</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient – physician</td>
<td>12</td>
</tr>
<tr>
<td>Physician – physician</td>
<td>1</td>
</tr>
<tr>
<td>Patient – ICT application</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>17*</td>
</tr>
</tbody>
</table>

* Number of total observations differs from 16 due to the fact that some objects can offer more than one type of communication

Source: own research.

The next criterion is category of activity. All e-health services may be divided into three groups. The first one is data collection and examination descriptions, where medical data is passed to physician, interpreted and sent back to patient. Simultaneous presence of both sides isn’t necessary. Remote monitoring is the second category. It means a possibility of distance monitoring of patient’s vital parameters thanks to sensors and other devices installed in patient’s house as well as ICT systems required for data exchange and processing. Interactive services, that offer the ability of conducting a medical consultation using audiovisual equipment, are classified as the last group [24]. The results of category of activity analysis were presented in the table 4.
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spatial information

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection and examination</td>
<td>10</td>
</tr>
<tr>
<td>descriptions</td>
<td></td>
</tr>
<tr>
<td>Remote monitoring</td>
<td>10</td>
</tr>
<tr>
<td>Interactive services</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29</strong>*</td>
</tr>
</tbody>
</table>

* Number of total observations exceeds 16 due to the fact that some objects offer services that can be classified to more than one category.

Source: own research.

Main aims of activity represent the next aspect of comparative analysis. These detailed aims cannot be classified to a closed, general set of aspects as they vary significantly between every object. Yet, to sum up, general aims were as follows: improving the effectiveness of treatment, creation a sense of greater security for patient, shortening diagnosis time, creation of modern medical services based on ICT solutions, increasing of the availability of specialized medical care or improving the quality of life. Also a review of diseases taken into consideration in analyzed e-health services was made and it’s results are presented in the table 5.

**Table 5. Disease information and supplied services**

<table>
<thead>
<tr>
<th>Information and supplied services</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG (electrocardiogram)</td>
<td>6</td>
</tr>
<tr>
<td>Medical data processing</td>
<td>6</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2</td>
</tr>
<tr>
<td>Dialysis</td>
<td>1</td>
</tr>
<tr>
<td>Expectant mother and fetus care</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>Anility</td>
<td>1</td>
</tr>
<tr>
<td>Stroke</td>
<td>1</td>
</tr>
<tr>
<td>Asthma</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong>*</td>
</tr>
</tbody>
</table>

* Number of total observations exceeds 16 due to the fact that some objects offer multiply services.

Source: own research.

Determinants of further development and dissemination are possible challenges that have to be met to assure future e-health services development. Crucial determinant was reimbursement from the National Health Fund as many patient simply cannot afford new e-health services. Without a reimbursement program, numerous services may stay niche. For some projects, a grant from European Union was pointed as a determinant of further development, too. Technical considerations such as: purchase of medical equipment or transmission and image processing are also very important. Another determinant is reaching interest among patients that may not be aware of new, emerging services. To close this list also some innovative concepts and exchange of experience should be listed. These determinants doesn’t have equal impact on every service but they burden in some measure. Summary of this part of analysis was presented in the table 6.
Table 6. Determinants of further development

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reimbursement from the National Health Fund</td>
<td>7</td>
</tr>
<tr>
<td>Grant from European Union</td>
<td>1</td>
</tr>
<tr>
<td>Technical considerations</td>
<td>2</td>
</tr>
<tr>
<td>Interest among patients</td>
<td>4</td>
</tr>
<tr>
<td>Innovative concepts and exchange of experience</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

Source: own research.

Possibility of estimation influence on the population refers to i.e.: changes in quality of life, medical care advance, improvement of health and welfare or progressing some disease control level. 10 out of 16 analyzed objects were classified as possible to measure this influence. Five observations that couldn’t be put into this category were described as “Difficult to assess the impact on the population”. The cause may be sought in type of activities as all of them were electronic patient record or ICT platform for data collection and processing. The amount of users wasn’t defined and environment wasn’t controlled.

The last category, namely key technologies, was a review of medical and ICT solutions improving spatial data collection and processing. This set of technologies consists of:

- software that allows hospitals to receive notifications and data of patients transported to hospital in ambulance,
- defibrillator-monitor equipped with modules for data processing and transfer,
- cloud computing,
- mobile ECG devices transmitting results via mobile phone,
- mobile holters,
- Web Service engine and presentation engine for user interface handling,
- Virtual Private Networks,
- Weight with Bluetooth,
- blood pressure monitor device with Bluetooth functionality,
- computer application for exchanging data,
- mobile cardiococography device,
- electronic platform collection, analysis and dissemination of digital resources for medical events and electronic patient record.

The aim of the analysis was to define services, ways of development, technical aspects and potential barriers of in absentia healthcare in Poland. The range of collected spatial data differed according to geographical range of the service or analyzed diseases. Results of the above analysis was a starting point for determining possible future in absentia healthcare trends that were described in the next point.
3. Possible future trends of in absentia healthcare

Currently in Poland more and more projects in the field of in absentia healthcare are carried out. After more than 20 years of various trials we can observe a growing number of healthcare facilities that are using various ICT tools. This trend applies to all levels of governance, from local through regional to the national (see figure 1).

![Diagram showing development directions of in absentia initiatives in Poland](image)

Figure 1. The basic development directions of in absentia initiatives in Poland

Source: own research.

Unfortunately, this growth is too slow in comparison to other EU countries. Sources of e-health initiatives are strongly dispersed (too many individual initiatives). What is more, some of them are overlap with each other (also at national level of management). Therefore, there are important problems that should be the subject of interest to both practitioners and researchers. Conducted analysis has shown gaps and possible barriers of development that should be resolved:

- technological (especially lack of computer equipment in hospitals),
- financial (including refunding from National Health Service),
- legal restrictions,
- problems with interoperability between existing applications,
- lack of cooperation between institutions at different level (territorial range).

Perhaps some of restrictions listed above could be avoided if solutions such as those in Sweden were applied. For example, implementation of electronic prescriptions in Sweden required the integration of multiple actions at lower levels of management (bottom-up approach). According to Åstrand [1, p.20] “in the year 2006, sixteen EHR systems were approved to transfer e-Prescriptions to pharmacies. An independent web site offered ePrescribing functionality too”. Figure 2 presents how the e-Prescription platform in Sweden was created.

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4 See also [17. p. 165-168].
5 More good e-Health practices from around the world can be found, among others, in [8].
Another important trend of in absentia healthcare can be connected with using ICT tools in order to involve more people (no matter where they are) in prevention activities. This is due to the fact that prevention, in addition to the beneficial effects on health, is also important from a financial point of view. Shift of focus from treatment on prevention entails much less cost.

In absentia healthcare patients may be dispersed geographically at a wide area. Although in analyzed services, some new technologies were present (i.e. cloud computing), ICT may play a more crucial role thanks to Internet of Things (IoT) intrusion. In this concept individually addressable, physical objects are connected to the Internet to identify themselves to other devices basing on the TCP/IP stack. Individual, independent, adaptive, responsive and self-configurable entities can cooperate constantly with each other to ensure omnipresent communication with peers and servers on the Internet [12]. This communication model may improve the quality and stability of in absentia healthcare as data can be transferred without human intervention and processed with higher accuracy and lower amount of time needed.

4. Conclusions

More and more healthcare facilities introduce ICT tools to support healthcare. Examples of such tools have been presented in the paper. What is important, most of them manage a variety of spatial information and could be supported by the conception of GIS. In Poland we can observe interesting initiatives, projects and companies at local, regional and also national level. Taking into account the increasing diversity of such solutions interoperability standards in the field of communication and data exchange should be introduced as soon as possible. In the face of the obligation to introduce electronic medical records and the challenges of cross-border care a fundamental question arises: do we still have time?
Bibliography


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TRENDY ROZWOJU TECHNOLOGII INFORMACYJNO-KOMUNIKACYJNYCH (ICT) WSPOMAGAJĄCYCH ZARZĄDZANIE INFORMACJĄ PRZESTRZENNĄ W OPIECE ZDROWOTNEJ IN ABSENTIA

Streszczenie

Wykorzystanie rozwiązań ICT w diagnostyce oraz profilaktyce może już niedługo okazać się jednym z kluczowych elementów opieki zdrowotnej. W związku z tym autorzy niniejszej pracy postanowili dokonać analizy rozwiązań tego typu występujących na polskim rynku. Celem artykułu jest analiza aktualnych trendów w zakresie rozwiązania opieki zdrowotnej na odległość, które mogłyby być wspomagane poprzez rozwiązania typu GIS oraz identyfikacja problemów, które mogą się wiązać z ich implementacją.

Słowa kluczowe: zarządzanie ochroną zdrowia, ochrona zdrowia, analiza rynków ochrony zdrowia

Marta R. Jabłońska
Karol Korczak
Department of Computer Science in Economics
Institute of Applied Economics and Informatics
Faculty of Economics and Sociology
University of Lodz
90-255 Lodz, 3/5 POW Street
e-mail: mjablonska@uni.lodz.pl
karolk@uni.lodz.pl