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## **INFORMATION TECHNOLOGY IN HEALTH CARE MANAGEMENT**

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**Abstract:** Information and communication technology tools are nowadays present in each institution or business entity. They allow optimizing management. In the case of health care agencies, they also allow improving quality of medical services. The aforementioned tools are not only computers and software but also computer network or other external devices. Presently, in the age of the information society, on-line medical services via the Internet gained in importance. These services reduce costs of health centers functioning and simplify access to specialists, shorten waiting time for an appointment or treatment, allow making remote registration, remote examinations and treatments.

**Keywords:** information technology, telemedicine, health care.

### **1. Introduction**

Computerization of each organization, regardless of whether it is a trading, manufacturing enterprise, state or private entity, is associated with a desire to improve management processes and operational effectiveness. Among the most important factors which have an impact on achieving expected results with the involvement of the anticipated funding, appropriate defining of the computerization process objectives should be mentioned. Regarding health care agencies, these objectives can be divided, with respect to the area of implementation, into the part related to the management – commonly called the gray part – and medical care – known as the white part. In the case of medical facilities, one should also consider a very important social purpose. The gray part objectives should establish among other things: financial savings, automation and optimization of information flows both within the unit and its environment. Environment involves different types of institutions participating directly or indirectly in the process of health care, such as Social Insurance Company (ZUS), The National Health Fund (NFZ). Regarding the white part, objectives should include: improvement of the medical information flow, increased and facilitated patient access to medical services, improvement of the quality of medical services.

This structure of computerization objectives illustrates well the purpose of the following statement: “Information technology projects targeting is associated with answering the question about the relationship of information technology systems with the objectives and tasks of the organization itself” [Grabara, Nowak (Eds.) 2002, p. 23]. The precedent objective should always be improving the quality of medical services and facilitating access to them. This facility can be achieved, among other things, through the initiation of various e-health functions, including electronic registration, electronic access to tests results, remote health monitoring, etc. In this respect, it should be noted that health care facilities, by virtue of their functions, play a special role in the information society. The computerization objectives of each unit performing social functions should meet all citizens’ demands for the actions performed by its functions in society.

## 2. Telemedicine

The term “telemedicine” means the combination of medicine, information and communication technology. Among the various possible applications of e-health, control function attracts considerable attention. The area of control function interest includes, among others, monitoring of individual organs and patient–doctor on the line contact. When using devices that transmit information directly from the patients residence to the health center and also from the patient to the center, on the one hand, one obtains a considerable financial savings and, on the other hand, irrational effects. These effects are relative to, e.g., better well-being of the patient lying in his or her own bed, more free and hence also available beds in health facilities for patients in need. This situation may affect elderly people (whose number increases due to the observed phenomenon of the aging of contemporary societies), who by virtue of their age require medical care, the chronically ill and undergoing recovery. All the mentioned groups of people have to meet appropriate criteria so that their state of health could be monitored through distance by appropriate devices and that they could remain in their homes. The most important include the possibility of an extended specialist response in case of specific emergency.

This condition is directly related to the type of a disease, which decides whether the patient requires hospitalization or simply monitoring the state of his or her health. This form of medical assistance also helps a significant number of people to get access to highly qualified medical personnel [Bliźniuk, Nowak (Eds.) 2006, pp. 100–102].

Basic telemedicine services are [Knosala (Ed.) 2010, pp. 328–329]:

- teliagnostics – exchange of long-distance medical opinion, examination,
- teleradiology – transmission of medical images such as X-rays or ultrasound at a distance, e.g., for the purpose of their evaluation or opinion,
- telepathology – testing samples by the equipment of other medical centers, such as testing samples with a microscope,

- tele-endoscopy – electronic transmission of images obtained by an endoscope,
- telecardiology – uploading to diagnose images or, e.g., electrocardiogram results (EKG),
- teleconsultation – usage of electronic platform to consult the opinions of experts, or to provide medical consultations by a physician at patient's house,
- teleeducation – usage of information and communication technologies for educational purposes, e.g., providing training for professionals from all over the world, showing students different types of surgeries and medical treatments,
- teleoperation – one of the most technologically advanced services for long-distance medical treatments, therefore one uses medical robots which are controlled by the specialist from anywhere in the world.

One of the first use of telemedicine services was consultations of two or more specialists and trainings. Webcams, projectors and computers are used to do it. After turning the camera on and connecting through the Internet with another specialist performing the same steps, on their computer screens there appeared an online picture with a consultation partner. In the almost real-time (due to technological limitations of this type first solutions and still slight network performance, one often observed transmission delays) specific medical cases could be consulted. In the case of training in the classroom there was a computer with a webcam connected to the Internet and a projector. The rule is exactly the same as in the case of consultations described above.

Depending on the time in which telemedicine services are held, one can distinguish historical and real-time telemedicine. Historical telemedicine is based on the analysis and processing of information collected before. In turn, on-line telemedicine is associated with the necessity of providing services in real time. Research, results of analysis, etc., need to be made immediately [<http://www.univ.rzeszow.pl/ki/teledycyna/index.php>, 20.10.2011].

Telemedicine often involves the use of very complex devices, but the basic forms of it are possible to apply by using relatively simple tools. Regardless of the level of service, telecommunication connection remains the most important. Fast and providing failsafe operation link connections are the basis for the provision of medical services at a distance. It is not difficult to imagine what would happen if during the surgery or medical consultations connection was lost. Other devices, which are relatively inexpensive and commonly used are means of communication. What is more complex is devices monitoring and collecting medical data. The group of the most technologically advanced and also the most expensive equipment used in the area of telemedicine includes robots helping to perform remote operations.

Telemedicine allows providing medical services with a very diversified level of complexity. The simplest are actions connected with text or voice sending medical advice. While considering applied technical equipment, what is more complicated is services connected with remote monitoring of health status. The most advanced is conducting operations at a distance, during which the doctor, even at a considerable

distance from the operating room, often makes very complicated surgical procedures. One also should not forget about its application in medical students education or conducting distance consultations and conferences [Bliźniuk, Nowak (Eds.) 2006, pp. 107–109].

Among the range of benefits arising from the use of telemedicine the following may be mentioned [Knosala (Ed.) 2010, p. 331]:

- facilitating access to medical services for people so far often characterized by limited access, e.g., because of their residence: the inhabitants of villages and small towns, because of mobility restrictions, etc.,
- obtainment of access to specialists from large centers often located in other countries, or even on other continents, by the smaller health care facilities,
- improvement of the quality of medical services,
- significant reduction of time needed for diagnosis and medical assistance,
- increase of the scope of medical assistance in special cases, e.g., disasters (natural and others associated with daily human or community functioning),
- frequent lack of necessity of approaching the doctor to the patient or the patient to the doctor,
- obtainment of savings in the functioning of health facilities associated with the optimization of usage of their material and human resources,
- increase of the number of persons admitted to a specialist,
- access to diagnostic equipment – smaller institutions which often do not have sufficient financial means to purchase specialized equipment can use other units resources,
- increase knowledge of medical students and medical workers in general – participation in training, teleconferences, virtually in various medical treatments with different level of difficulty.

The cost of telemedicine services can be very varied, much cheaper than traditional medical services, at the same level, or even more expensive. It is dependent on several factors, connected with, e.g., the population density, the cost of information technology and telecommunications elements, the amount of health facilities, the number and the knowledge of physicians, etc. Health care should not be viewed solely in terms of profitability of operations, but quality and accessibility of medical services provided to society. Therefore, the most important exponent should not be the profit, but human life and health. In this aspect, telemedicine services, regardless of their costs, are an optimal solution.

### **3. RFID in health care**

Information management support in health care facilities should implement three major tasks, such as supporting the medical staff, the technical part and patients. Patient support is defined here as informing about the results of current analysis, the terms and scope of future analysis, medical recommendations, etc. Medical service,

because of its nature and scope of duties, should also be divided into the medical and nursing section. Supporting the work of doctors should provide access to complete information about patient health: tests results, possible suggestions concerning health, recommendations. This kind of information should describe the whole patient condition, and not be confined to the field in which the doctor who is currently performing medical services is specializing. Medical data have to include both the descriptive and graphical part – X-rays, ultrasound pictures, etc. Due to the fact that information tools should support the work of the group of professionals as far as it is possible, in the case of a medical service information system based on collected data should be able to suggest specific events of medical service. This concerns indicating, on the one hand, possible diseases or abnormalities in organs functioning, on the other hand, procedures of algorithms for selected treatments and possible consequences. Nursing part should provide access to information necessary due to the location (branch), patient stay, give information about treatments, medications that should be given (dosage) and include knowledge of how to proceed when certain circumstances appear.

Finally, the technical part should contain all information necessary to manage a health center and fulfill the role which is very similar to the systems supporting the management of a traditional economic entity. The process of treating the patient during his or her life is associated with the necessity to “visit” many, often specialized institutions. We do not encounter a situation when the patient throughout his or her life is treated in one specified place. A person should be treated as a complex system in which the state of the selected “area” affects the state of other “areas”. Because of that, all the medical information describing the current and previous health status should be available in each institution, (regardless of its location) where at any time the patient decides to go. Selected information should be available also for a number of institutions not taking directly part in the healing process, such as the National Health Fund (NFZ) or Social Security (ZUS). The availability of data regardless of the residence is an ideal solution, but requires unification of information standards in all elements of the health system and adaptation of many different systems to work together [Knosala (Ed.) 2011, pp. 264–266].

Because the healing process combines dynamic and static operations supporting it, information tools should be also characterized by such abilities. Access to all necessary data should have both the doctor treating the patient in generally good condition in a medical office, but also the doctor treating the patient after an accident or, for example, heart attack, when action must be taken very quickly. This entails a need to involve specific technical equipment and the application of specific procedures. Access to medical data should be possible to gain, on the one hand, after entering, e.g., the patient’s personal identity number (PESEL) and, on the other hand, by using RFID technology automatically when patients find themselves within range of a receiving device, e.g., PDA computer [Knosala (Ed.) 2011, pp. 37–38].

The possibility of applying RFID technology in health care facilities is not limited only to read information about the patient. It has a much wider application.

It can be used to collect and obtain all necessary information about the material and human resource of the institution, thereby allowing optimization of the management in these areas. With usage of RFID technology, one can label any device, employee (both medical staff and administration), medications, or even business attire. Only a need decides about what kind of information a particular object will contain.

There are many benefits of using RFID. One can mention the capacity for rapid implementation of owned hardware inventory resources. This is even more important because the medical equipment is usually very expensive. Continuous information on the number of owned equipment allows arranging its use in terms of the present, future time, and also plan possible purchases. Access to information is not limited only to checking the number. At any time, one can check where each equipment is located. This allows delivering rapidly all the necessary equipment to a selected room (operational), find the doctor who because of the nature of the necessary to perform surgery should attend at a specified place and at any given time as soon as possible.

Identification and inventory of equipment has another measurable advantage for health care. The mentioned advantage is the possibility of checking whether the number of medical equipment, e.g., from before surgery matches the after surgery number. Thanks to that, one can achieve certainty that no medical instrument is left in the patient's body. RFID is also the possibility of receiving, issuing, monitoring and tracking particular drugs. This allows minimizing the number of medical malpractices, increasing the availability of medical services, reducing operating costs, improving patient satisfaction. The doctor or the nurse at the entrance to the room receive immediate and complete medical information on all patients staying there. This technology apart from a number of advantages has also some disadvantages. These include, e.g., patients and health staff concern connected with the loss of privacy, high implementation costs, the possibility of negative devices impact on medical equipment, the fear of introducing new solutions, which in the opinion of many workers can contribute to the employees redundancy [Knosala (Ed.) 2011, pp. 86–94].

Among the processes in health care facilities that can be optimized through the use of RFID technology, one can identify [Chrobak 2007; *Asset Management...*]:

- patient registration,
- identification of patient data,
- identification of patient location,
- dosage of medicines for patients,
- collection of patients medical data,
- information flow about patients,
- monitoring patients at high risk of possible missing (suffering from memory problems),
- availability of the physician – the doctor who does not need to seek medical equipment has more time for contact with the patient,

- significant reduction of potential medical errors,
- reduction of the inventory amount,
- management of the equipment life cycle,
- reduction of problems with the search for medical devices,
- inventory of medicines and medical devices,
- minimization of the work of medical staff not directly related to medical care.

As mentioned earlier, one of the objectives of the functioning of the information technology tools in health care facilities is associated with the service and patient supporting. Having a portable computer and located in the health facility, the patient should have access to specific information concerning his or her health. Such access should also be possible after logging into the system by the patient located in any place, the only condition is having connection to the Internet.

Using the Internet, one should also have possibility to complete, e.g., registration to a chosen specialist. Another issue of supporting the patient is organizing points of Internet access in health care facilities. This is particularly important in hospitals, where patients are often forced to stay for a longer period of time. Providing opportunities to access the resources and functionality of the network, including facilitating contacts with the family improves mood and makes a stay in hospital less inconvenient.

In the scale of the National Health System, one seeks to integrate all the medical data of patients and health centers. The Act of April 28, 2011, about the information system in health care is consistent with these assumptions. This Act, signed by the RP President on May 18, 2011 assumes the creation of a medical information system. Among its key objectives there occurs integration of all medical information from each institution related to health care. This system will be available to all the interested who have a need to use its resources. The patient will get the ability to arrange to any specialist remotely (regardless of his or her place of employment) and to check how long he or she has to wait for such a visit. Exchange of medical information about registered patients between different health centers, issuing electronic versions of prescriptions and referrals to the study, will also be possible. The effect of implementing the system also has to be the lack of simultaneous appointment to more than one physician skilled in a particular domain, issuing prescriptions for deceased persons, falsifying prescriptions and bills [Przez internet sprawdzimy... 2011; Do lekarza zapiszemy się... 2011].

In terms of management optimization and entry into force of the above mentioned Act, the characteristics of the information systems supporting management of health institutions can be presented as follows [Knosala (Ed.) 2011, p. 595]:

- ability to operate the procedures and medical services,
- support for registration, including online registration,
- full compliance with the information standards of other institutions and individuals related to health care,

- ability to handle all activities related to the gray part management – the administration of the facility,
- ability to expand, for example, in the case of extending the offer.

Considering issues related to possibilities and benefits of RFID applications in healthcare, one cannot forget about the problems of safety of collected and processed data. This issue particularly concerns personal data. Users of RFID tags should be ensured that unauthorized persons will not have access to any personal or medical information. Personal Information means any data that directly or indirectly allow identifying an individual. The necessity for data protection in solutions using Radio Frequency Identification RFID is also indicated by the European Commission in the recommendation from May 12, 2009. This recommendation imposes on RFID operators an obligation to conduct an assessment of impacts on data protection and privacy before RFID use, and make their results available to authorities and institutions. [*Ramy oceny skutków...* 2011; [http://ec.europa.eu/information\\_society/policy/rfid/documents/recommendationonrfid2009.pdf](http://ec.europa.eu/information_society/policy/rfid/documents/recommendationonrfid2009.pdf)]

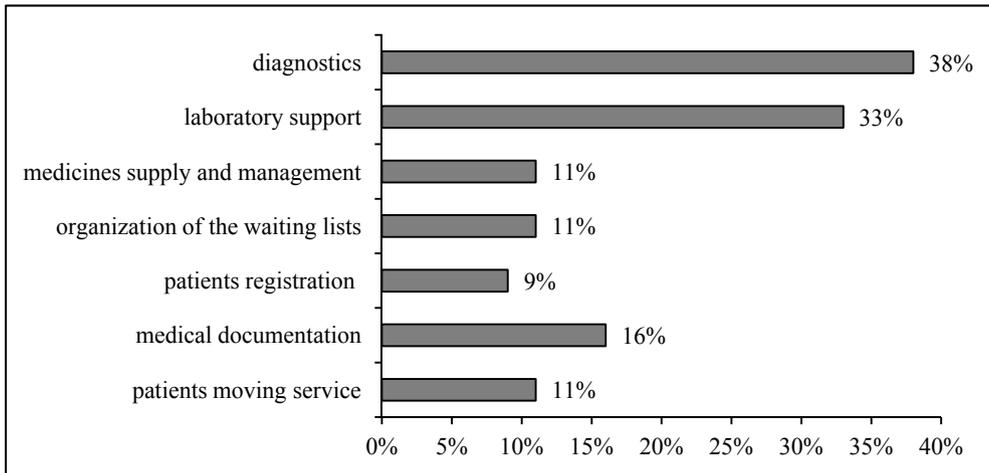
One of the examples of information technology application in the management of health facilities is electronic card system for patient registration implemented in Silesia. The card stores basic data needed for registration process and subsequent reporting between health care providers and the NFZ. Thanks to implementing such a system, manual data entering is no longer necessary – it significantly lengthened the process of getting to the doctor, and which in turn often was the cause of frustration and nervousness among both patients and medical staff. Obviously, the system has not eliminated queues, but it undoubtedly contributed to their reduction. It should be also regarded as a small step to achieve integration in health care information.

#### **4. Information technology in health care – the needs and reality**

In 2009 in hospitals across the country a study entitled “Resources and potentials of health care in the field of information technology and their participation in the teleinformation space” was conducted. The study was related to the plans of the Ministry of Health regarding the computerization of health facilities. Prepared questionnaires were sent to each hospital, excluding prison infirmaries and military units, which were registered as hospitals – the survey covered 720 institutions. The questionnaire was filled by 189 institutions – 27% of all surveyed [*Zasoby i potencjały zakładów...* 2010].

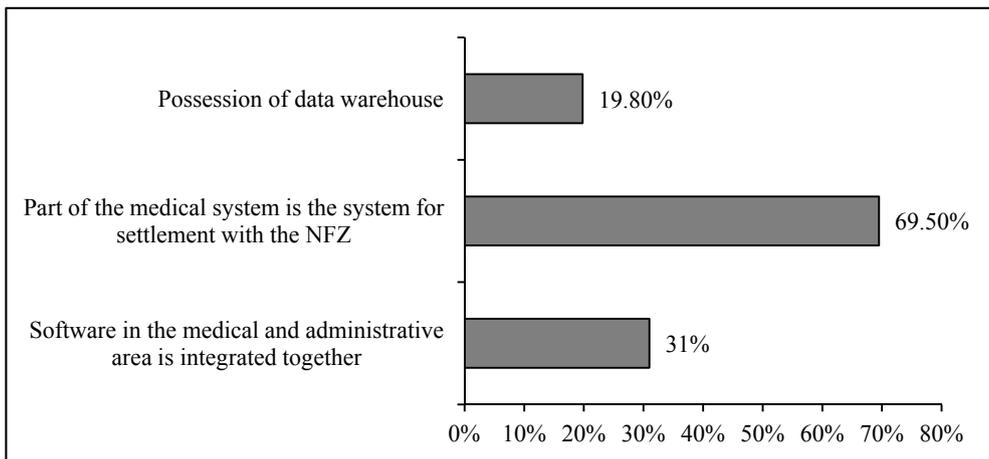
According to the research results, 97% of hospitals possess specialized computer software for medical needs. This software does not allow, however, in many cases for the realization of specific actions. Figure 1 presents the percentage of hospitals which do not have specified systems supporting selected activities.

The level of computerization of hospitals, associated with the ability of information cooperation with patients and other institutions relevant to health as well as the automation and optimization of the work of a unit can be described by analyzing the level of the integration of the used software (see Figure 2).



**Figure 1.** Percentage of hospitals with no specialized medical software to support the implementation of selected activities (187 units replied)

Source: *Zasoby i potencjały zakładów...* [2010].

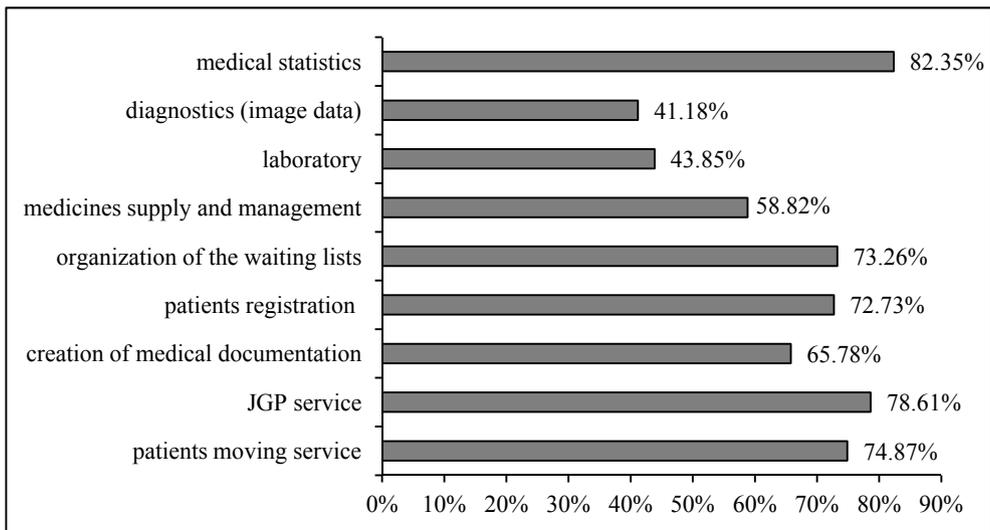


**Figure 2.** Hospitals according to the degree of the integration of owned information systems (187 units replied)

Source: *Zasoby i potencjały zakładów...* [2010].

On the basis of Figure 2, it can be stated that only 31% of the surveyed hospitals possess integrated information technology system. This affects negatively the management optimization. Only integrated systems, which can work together, are able to contribute to a better use of resources both in the medical area as well as administrative, causing in this way the ability to reduce operating costs.

Access to medical data as well as data which have influence on unit management by interested persons (both within an institution and outside it) is possible only under the condition of possessing by installed information technology systems data transmission functionalities. Access to all necessary data generated and stored in the systems is one of the most important factors affecting the efficiency of computer systems, and thus the efficiency of the hospital work. Possibility of data transmission by computer systems installed in the surveyed hospitals is shown in Figure 3.



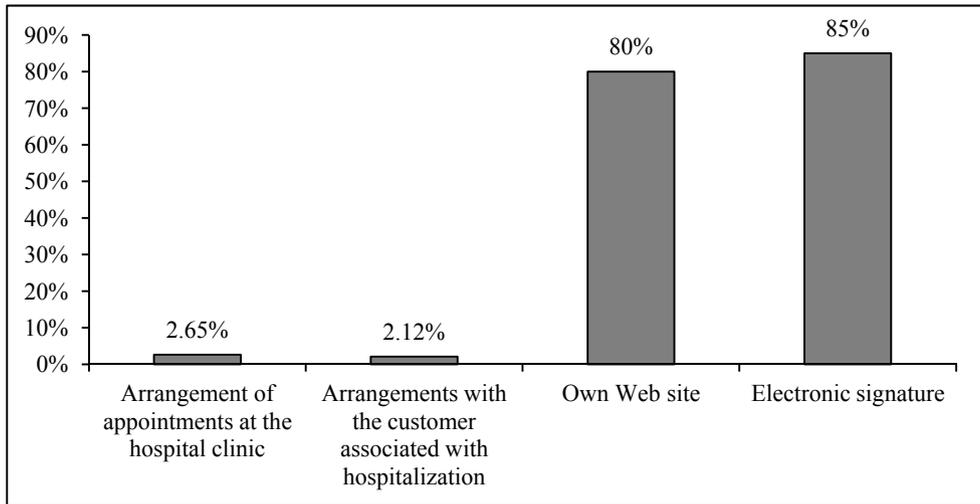
**Figure 3.** Specialized medical software with the functionality of data transmission (187 units responded)

Source: *Zasoby i potencjały zakładów...* [2010].

Figure 3 shows that the worst situation in terms of data transmission capabilities occurs in the area of diagnostics, laboratory (medical part), and supplies and medicines management (administrative part). This results in the medical area in reduction of the ability of the treatment process optimization – the doctor from the level of used system does not have access to necessary information required to make a diagnosis. Deficiencies in the management of the flow of drugs cause the inability to optimize this process, which manifests itself, *inter alia*, by generating certain costs.

Possession of integrated information technology systems has a direct impact on the optimization of the management of health institutions. Nowadays, their functioning is also affected by the ability to exchange information with patients through electronic signature. Figure 4 presents the objective of having access to the Internet in the surveyed hospitals.

As shown in Figure 4, Internet access in the vast majority is used to run their own web pages and the flow of documents signed electronically. Only 2.65% and 2.12%



**Figure 4.** The objective to have access to the Internet (189 units replied)

Source: *Zasoby i potencjały zakładów...* [2010].

of the hospitals, respectively, use it to active cooperation with patients, that is, agreeing terms of hospital clinic visits and consultations with patients including all the issues related to hospitalization. In today's society, which commonly uses the Internet, electronically provided services are factors that may determine the position of the competitive facility.

## 5. Conclusion

Contemporary health care institutions are in large part private. Like all other economic organizations they are supposed to be competitive, try to attract new and maintain current customers (patients). Competition forces to seek means which can reduce operating costs while increasing quality of medical services. As in other areas of activity, in health care institutions one of the most important tools used for this purpose is the elements of information and communication technology. This includes information systems, computer equipment and support.

The implementation of information technology systems faces the same type of problems and dangers as the organization functioning on every other market. The implementation process may end up in failure. Unlike in the case of other institutions or entities, implementation failure may contribute indirectly to the loss of health. In order to achieve the desired effect, introducing the structure of the relevant software is not enough. It is also necessary to install a range of modern electronic devices which are supposed to increase functionality of the software. The most important task of these devices is the optimization of processes related to information management.

One of the most important technologies which allows increasing health facilities efficiency is RFID. A flow control system that uses radio waves allows the optimization of management in each area of health care facilities. This concerns both the medical and administrative part. It allows, *inter alia*, controlling resources, reducing purchases, better using technical infrastructure, optimizing the work of employees, integrating medical data, shortening access to medical data and finally reducing medical malpractice. Introduction of this technology, however, may be associated with decreased number of full-time jobs and a sense of considerable interference of a management team in staff functioning.

Modern society is increasingly being called information society, that is, the one in which a number of traditionally handled activities (requiring physical presence) can be implemented without leaving the computer. One of the areas of such a society model is e-medicine. It includes, for example, electronic filing, making appointments for specialists, remote access to tests results, the flow of information between all the users of a national health system.

Coexistence of health facilities in the common system, however, entails a need for matching used data standards. All information technology systems need to have assured ability to exchange all the necessary information. The idea and the goal is to make this mutual flow of information include both the information necessary to deal with administrative matters and medical data. This will help to optimize the treatment process. Each doctor admitting the patient will have instant access to all the necessary information describing the current medical appointments (in any health center), test results, etc.

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## TECHNOLOGIA INFORMACYJNA W ZARZĄDZANIU JEDNOSTKAMI OCHRONY ZDROWIA

**Streszczenie:** Narzędzia technologii informatycznej i komunikacyjnej są obecne w każdej instytucji czy podmiocie gospodarczym. Pozwalają one na optymalizację zarządzania. W przypadku placówek ochrony zdrowia pozwalają również na polepszenie jakości świadczonych usług medycznych. Narzędzia te to nie tylko komputery i instalowane na nich oprogramowanie, ale również sieć komputerowa czy inne urządzenia zewnętrzne. Obecnie w dobie społeczeństwa informacyjnego znaczenia nabiera świadczenie usług medycznych *on-line*, za pośrednictwem sieci Internet. Usługi te obniżają koszty funkcjonowania ośrodków ochrony zdrowia oraz ułatwiają dostęp do specjalisty, skracają czas oczekiwania na wizytę czy zabieg, pozwalają na zdalną rejestrację, a także dokonywanie zdalnych badań i zabiegów.

**Słowa kluczowe:** technologia informacyjna, telemedycyna, ochrona zdrowia.