Computing in medical practice

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Abstract

Objective: Currently, information technology is part of several aspects of our daily life. The objective of this paper is to analyze and discuss the use of information technology in both medical education and/or medical practice.

Sources: Information was gathered through non-systematic bibliographic review, including articles, official regulations, book chapters and annals. Direct search and search of electronic databanks in Medline and Lilacs databases were also performed.

Summary of the findings: This paper was structured in topics. First, there is a discussion on the electronic medical record. The following aspects are presented: history, functions, costs, benefits, ethical and legal issues, and positive and negative characteristics. Medical decision-support systems are also evaluated in view of the huge amount of information produced every year regarding healthcare. The impact of the Internet on the production and diffusion of knowledge is also analyzed. Telemedicine is assessed, since it presents new challenges to medical practice, and raises important ethical issues such as “virtual medical consultation”. Finally, a practical experience of modernization of a pediatric outpatient center by the introduction of computers and telecommunication tools is described.

Conclusions: Medical computing offers tools and instruments that support the administrative organization of medical visits, gather, store and process patient’s data, generate diagnoses, provide therapeutical advice and access to information in order to improve medical knowledge and to make it available whenever and wherever adequate decision-making is required.

Introduction

Although we live in the Information Age - characterized by an unprecedented explosion of information and knowledge - doctors continue to collect, process, record and search for information using the paper-based models of the Industrial Age.

During a traditional medical consultation, for example (be it in a public health service, and basic health center, an outpatient clinic, a private health service or a private practice), a patient generates a set of clinical and administrative data that are collected, stored and processed.

O processo inicia-se com o apoio de uma secretária, que agenda uma nova consulta ou retorno, preenche uma ficha de identificação e abre um prontuário médico (folhas soltas, fichário, pasta, envelope) para ser posteriormente preenchido pelo médico.

The process begins with the assistance of a secretary who books a new consultation or revisits, filling in a patient information form and creating a medical record (loose sheets, file card, folder, envelope) to be completed later by the doctor.

During the consultation, the doctor notes data obtained through anamnesis, results of physical examinations such as weight, height, blood pressure and head, abdominal and chest circumference. The doctor uses these data to generate the most probable diagnostic hypotheses, which are confirmed or not by means of further questions, procedures and tests. Once the diagnosis is established, the doctor advises the patient and, if necessary, writes a prescription for a medication.

On certain occasions the doctor will need to seek further understanding, exchanging information with colleagues, reading texts from books, manuals, journals which may be available in the consulting room or at the library.

The field of medical information technology offers tools and instruments that can provide administrative support for medical consultations, gathering, storage and processing of patient data, the generation of diagnoses, therapeutic orientation and access to information with a view to improving medical knowledge and ensuring that this knowledge is available when and where it is needed.

The continued reduction in the cost of computers, their simplified use, improved access to the Internet via telephone lines or broad-band ADSL connections, the use of handheld or palmtop computers and wireless connections will certainly contribute to the improvement of medical services available to patients in places that lack specialists, as already occurs in various parts of the world. Doctors also have electronic access to thousands of scientific journals, atlases and even the most recent medical practice guidelines through a large number of medical schools and governmental and non-governmental organizations.

The electronic patient record (EPR)

The patient record, initially created to document information regarding the patient’s health and illness, has become much more complex and taken on an extremely important role in modern society: as the basis of the maintenance of the patient’s health; in the exchange of information between professionals; as the legal basis for medical actions; as a source of clinical research, in epidemiological studies, in the evaluation of the quality of care and of adverse reactions to drugs; as a source of ongoing medical education and learning; in the identification of specific patient groups; in the administration of health services, supplying the basic information for revenues and reimbursements, for the pre-authorization of payers, as the basis of the organizational planning and cost management.

In the past, the doctor had sufficient knowledge to provide virtually all the care necessary for the patient. The exponential growth of medical knowledge has led to the appearance of a range of clinical specialties.

The responsibility for the care of a patient is now transferred to different teams of professionals. The patient record may thus contain extensive annotations made by a number of health professionals, as well as large amounts of data such as laboratory tests, images, results of pathoanatomical examinations and different kinds of summaries.

The association between the growing generation of and demand for structured, accessible patient information at the same time as the development of information technology led to interest in the development of the electronic patient record (EPR).

The first attempts took place in hospital contexts more than four decades ago and were focused on the recording of sections of the patient record that were relatively easy to structure, such as those that contain diagnoses, laboratory results and medications. Narratives proved more difficult to collect in a structured format. Not only do medical professionals vary greatly in their ways of recording findings, but they also appear reluctant to enter the data directly into the computer.

In Europe, especially in the Netherlands, Sweden and England, considerable progress has been made in the development and implementation of EPR models, with the main focus being on primary care.

In Brazil, the interest in studying an EPR model arose in universities in the 1990s. Isolated efforts led to the development of EPR models in a number of institutions in the large urban centers.
In 1999, a Ministry of Health initiative proposed a minimum set of patient information to be included in an EPR in order for it to be compatible with the various Brazilian health information systems.10

The current EPR models, organized by time, by information source or by problem,11 offer an overview of patients’ information.

Besides keeping an electronic record of the patient’s clinical information, the EPR also serves a number of functions in the administrative and financial management of a practice. It frequently offers the ability to generate diagnoses according to the International Classification of Diseases (ICD-10),12 as well as access to classification and procedural tables such as the LOINC or that of the Brazilian Medical Association (AMB).13,14

Automated systems can generate reminders and alerts related to a large number of patient health variables, including suggestions for appropriate action to be taken. They can also clearly advise the health professional regarding the positive and negative predictive values of exams to be requested for the confirmation or rejection of a specific diagnosis.15

Current EPRs incorporate sophisticated electronic prescription systems to guide the doctor in the choice of the cheapest, most effective medications, and able to monitor the prescription and reduce the occurrence of adverse drug interactions.16

Given that different patient health care functions are increasingly shared between professionals of various disciplines, the effectiveness and efficiency of their intercommunication has a substantial effect on the performance of the group as a whole in the overall provision of health care.5

Modern EPRs thus include tools that permit communication, in a legible form, between different professionals, between professionals and patients and between professionals, hospitals and complementary health service providers. The use of EPRs via palmtop computers with wireless connections should have a substantial positive effect in avoiding loss of information in contact with patients that take place outside the normal work environment, such as in home care and field visits. It will also allow the recording of decisions taken during telephone consultations outside the consulting room. The use of these resources will enable doctors to collect, retrieve and analyze data when and where they are required.

Costs and benefits

It is difficult to create research protocols capable of investigating the differences in costs and performance of different institutions that use comparable paper-based and electronic records.

A number of studies have, nonetheless, demonstrated that the decision-support systems built into the EPRs reduce costs and improve the quality of patient care when compared to traditional paper-based systems.17

**Ethical and legal aspects**

Health professional regulatory and standards bodies such as the Federal Medical Council and the São Paulo State Regional Medical Council (CREMESP) have long been concerned with ethical and legal issues regarding patient records. CREMESP’s Manual of Ethical Principles for Medical and Health Websites recommends that “Just as in the case of paper-based patient records, electronic patient records containing data regarding patients in clinics, hospitals and analytical laboratories must be protected against invasions of privacy”.18

In relation to the EPR, important aspects such as availability, integrity, auditing, confidentiality and privacy must be standardized in a transparent manner.17,19

The Federal Medical Council recently assigned the definition of standards for the certification of programs for medical use to the Brazilian Society of Health Informatics (SBIS).

It should be pointed out that civil society in its entirety should pay special attention to the issue of patient information privacy, considering the possible effects of the introduction of a single patient identifier that will follow the implementation of the National Health Card by Brazil’s Ministry of Health.10

**The irreversibility of the EPR**

Faced with the explosion of information in the health field, the doctor can no longer memorize all the diagnoses, laboratory exams and treatments, as was possible for doctors until the middle of the previous century. Thanks to the computing and telecommunications resources now available, the current situation is one of a previously unimaginable abundance of information.

The EPR, which links all the patient’s information with information technology, will allow the return of the figure of the family doctor able to provide the best health conditions for the patient, now with access to all the necessary information and therefore very well informed.9

Further, the EPR represents an important change in the doctor-patient relationship, as it creates the necessary conditions for patients to interact with and participate in their care, with the information available in the patient record.

**Pros and cons of the EPR**17

**Pros:**

– the text is legible;
Cons:
- the EPR depends on the existence of hardware, software and other infrastructure: networks, electricity, maintenance, etc;
- the investments in hardware, software and training of EPR users are substantial;
- the EPR requires constant maintenance, updating and preservation of integrity of data, which requires different organizational approaches and investments;
- the use of the EPR requires training, both in the use of the computing tools and in the software itself. This training is frequently the cornerstone in the acceptance and use of the system;
- the privacy of the data must be maintained in the electronic medium, requiring considerable investments in security;
- consideration must be given to the difficulties experienced by health professionals with no former training in typing and maintaining the doctor patient relationship in front of the computer, and to the time thus spent in consultation.

Decision-Support Systems (DSS)
Decision-support systems (DSS) in medicine include all types of software that help doctors in problem solving. Under this definition decision-support systems include both data- and information-based systems and knowledge-based or Expert Systems.

According to the World Health Organization, the quantity of information in the health field doubles every three years, and affects the doctor in a range of ways: providing new diagnostic and therapeutic methods, through the appearance of new chemical principles, of innovations in molecular and genetic biology (bioinformatics), of information about drug interactions, etc.

Specialties, such as geriatrics, in which the doctor must prescribe five or six different medications, and the appearance of new laboratory tests, such as tumor markers, which are not always accompanied by adequate scientific confirmation, make DSS an obligatory instrument for appropriate medical practice.

DSS help medical professionals in the choice of the best laboratory tests to confirm a diagnosis, can propose diagnostic hypotheses for different clinical situations, help in the choice of the best treatment and can prevent undesired drug interaction situations.1,6

DSS can be integrated into the EPR, providing alerts and reminders as the patient’s data are stored, or can be separate systems that are used when the doctor needs specific support.

DSS can be installed on the computer of a single doctor or on the server of a health institution, or may be accessed via the Internet from any connection around the world - it is just a matter of finding them.

The Internet
The use of the Internet brings clear benefits for the doctor faced by the universalization and democratization of knowledge, with costs of access lower than those of other means used up to now.

The Internet has allowed doctors, other health professionals, patients and consumers to access medical information in unprecedented quantities. This access has the potential to accelerate the transformation of the doctor-patient relationship, from that of the medical authority administering advice and medications (sometimes with questionable patient understanding and adherence to recommendations) to one of the sharing of decisions between the patient and the doctor.20

Current technological knowledge allows rapid, safe and confidential access to detailed technical and scientific information via the Internet, both for doctors and for patients, as well as the remote delivery of tests and analysis of procedures (telemedicine), which can assist in clarifying diagnoses and allows discussion of therapeutic options.21

Although the Internet has brought the possibility of a more equitable distribution of knowledge, the liberty and variety of possible choices bring risks and doubts. When seeking information on the Internet, the doctor must rely on quality criteria established by representative university institutions, national and international health
organizations such as the Ministry of Health, the World Health Organization and the United States Food and Drug Administration or non-governmental organizations concerned with the quality of medical information on the Internet.10,22-28

It is important to draw attention to a new educational paradigm with appropriate use of the Internet: Distance Medical Education via Internet. Including undergraduate, specialist and postgraduate levels, it is the educational process that allows the doctor to study and keep up to date in a wide range of disciplines, without leaving the office and without having to adapt to course schedules.29

Um dos principais usos da Internet, ao lado do acesso à informação e ao conhecimento, é a comunicação através do correio eletrônico (e-mail), facilitando o contato entre os diversos atores envolvidos no cuidado com a saúde dos pacientes.

Some doctors have been using e-mail to communicate with their patients, with the option of encrypting their messages. In the exchange of electronic messages between the patient and the doctor, it should be emphasized that e-mails have specific characteristics, mainly concerning their relatively informal status, briefness, speed in reaching the receiver, and possibility of prompt response (provided the urgent character of the message is properly identified).19

The use of the e-mail in the exchange of information between the doctor and patients has not been clearly regulated by medical ethical committees yet. Therefore, doctors have to be very careful with this means of communication and try to avoid its use to make important decisions, which necessarily require the presence of the patient. An electronic mail is a document, and therefore it should always be attached to the patient record (in either printed or electronic form). There is no specific regulation about how this type of service should be charged, which frequently burdens the routine of doctors, who are required to read and answer several e-mails a day.30-32

Virtual medical consultation

We consider that the first consultations should be in person, so that a link between the doctor and the patient may be established and the subsequent virtual relationship (via e-mail) may be effective. The maintenance of mutual trust is essential; without that, the doctor-patient relationship will not be preserved, compromising the

Telemedicine

Telemedicine may be understood as the use of telecommunications and computing resources applied to remote diagnostic and therapeutic procedures, consultations and guidance, in addition to continued medical education and videoconferences, with images being transmitted via e-mail (using cables and fiber optics) or even via satellite.

In a country with continental dimensions such as Brazil, costs associated with transportation, stay and food for patients (and escorts) seeking medical advice account for great part of the financial resources of municipal and state health departments. In addition, this restricts the access of patients to diagnostic and therapeutic technologies that are available only in large cities. The adequate use of telemedicine resources may increase patients’ access to specialized medicine and consequently improve the quality of health care, with no need to involve transportation costs.33

Another important aspect of telemedicine is the possibility to spread the knowledge of specialists and make it accessible to other doctors, so that both doctors and patients can benefit from it. Brazilian doctors may improve/share their knowledge with colleagues from all over the world while accessing the latest information made available on websites of vanguard universities. As an alternative to congresses and forums where people are physically present, the telemedicine medical recycling process allows to reach a great number of doctors with no need for migration from one place to another and thus with extremely lower costs.

At present, knowledge is renewed at a quicker pace than it used to be. Therefore, it requires constant attention on the doctor’s part to what is happening in his/her field. However, if on the one hand information has become more democratized, on the other hand, it cannot be reached by everyone. The obstacles to this accessibility range from economic limitations to the lack of public policies, including individual resistance to making efforts so as to master this new means of communication.

Some practical advantages of online health care may be pointed out: no need to call and book visits, good cost-effectiveness, virtual access instead of physical transportation, establishment of a “bridge” with patients living in remote areas.

When using the Internet for medical purposes, it should be clear that 1) the information and/or opinion given cannot replace and/or discard a real consultation with the doctor who is aware of the clinical history of the disease and of the personal/family history of the patient, and 2) personal contact with the doctor is essential.

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patients’ expectations that the doctor will act according to their interest and benefit.

Other aspects of medical practice over the Internet need to be analyzed, such as those related to medical ethics, supervision by regulatory organizations, efficacy of online treatments, confidentiality problems, lack of identity (both the patient’s and the doctor’s) and lack of information provided by physical examinations, which could only be carried out in the patient’s presence.

When using the Internet, the doctor also has to pay attention not to get involved in embarrassing situations, such as those in which patients want to check or confirm their doctor’s conduct and therefore seek a second doctor online. Although patients have that right, the information sent to the second doctor by email will not always be the same as that given to the first doctor during the traditional consultation.

So, although the demand for a second opinion is present in the daily routine of doctors, and although the use of the Internet for exchange of mail has increased substantially – currently, it is as commonly used as regular mail or telephones –, federal and regional councils have not manifested a clear opinion about this subject up to the present moment.

Therefore, for the creation of online-doctor-type services, virtual medical guidance aimed at those with access to the Internet, it will be necessary to reassess the Code of Medical Ethics, in order to determine what should and what should not be done via the Internet.19

The Automated General Pediatric Outpatient Clinic at Hospital São Paulo, School of Medicine, Universidade Federal de São Paulo, Brazil

In the School of Medicine, great part of the learning process takes place at outpatient clinics, where the student acts as a doctor and learns to interact with patients, collect history and physical examination data, make diagnostic hypotheses, request laboratory and complementary tests, in addition to choosing the best conduct for each case.

Some factors have been associated with difficulties in this practical academic learning process: the great number of patients to be seen at outpatient care units of public hospitals, the amount of scientific information exchange among students and tutors, involving pathophysiology, propedeutics, diagnostic methods, differential diagnoses and treatment; on the other hand, the students face difficulties in obtaining data from the traditional medical records, and there are very few rooms aimed at individual care, etc.

Many efforts have already been made to improve the education of medical students. Currently, the use of modern tools and instruments derived from computer science and telecommunications constitutes one of the most promising resources.

Therefore, believing that the teaching of medicine should be submitted to some changes, the Department of Computing Science in Health, together with the head office of Universidade Federal de São Paulo (UNIFESP) and the discipline of General and Community Pediatrics of the Department of Pediatrics, proposed the development of a new learning methodology, to be evaluated by the General Pediatric Outpatient Clinic at Hospital São Paulo. Every year, this clinic sees approximately 5,000 patients, receives 100 students attending the fifth year of medical school and 18 residents.

The implementation of this teaching model at the General Pediatric Outpatient Clinic took place in February 1997, when all the offices of the clinic were equipped with computers and a clinical management software was developed by the Department of Computing Science in Health, called “Clinic Manager”. In addition to this software, support application software was also provided, as well as educational programs, drug interaction monitoring systems, the connection of the computers to the UNIFESP’s network, with access to the University’s database and to the results of laboratory tests carried out by patients of the clinic, and also access to the Internet. All tutors were trained prior to the beginning of the program and supervised by the Department of Computing Science in Health.

In 1998, the first assessment of this new method was carried out, based on questionnaires, interviews, and on the observation of attitudes and of the behavior of students.34

The main findings were:

– When the implementation started, the team in charge of assisting the patients showed some insecurity, fear and anxiety while using the computing resources. On the other hand, they showed great expectations, curiosity and were very stimulated by the new challenge.

– Consultations taking place at the beginning of the training program were long due to the little knowledge of computing sciences and/or typing skills shown by students and tutors.

– The implementation of computing resources improved the organization of services offered by the General Pediatric Outpatient Clinic and held the attention of students and tutors, allowing for the development of an active participation in the learning process.

– With the use of the clinical management software, it was possible to outline a profile for the medical care provided at the clinic, detect the main diagnoses made and thus decrease the incidence of drug interaction problems.35

With the adequate use of these computing resources by the student, the patient started to be followed up in a quicker, more organized and more effective way. As a result, the use of papers decreased/stopped, the time
spent on consultations decreased, clinical data started to be better organized, and the satisfaction of the users of the system was increased.

As the main conclusions of this initiative, we emphasize that, with the support of computing resources, it has been possible to improve the learning process qualitatively and quantitatively, since students have immediate access to information about their patients, to local and worldwide databases on various subjects related to the medical sciences, educational support through the use of educational programs and through distance education.

The doctor-patient relationship improves as the use of the computer becomes more common and as the necessary information becomes quickly and clearly available to the students.

The results of the evaluation of the use of computers in the consultations carried out by the students attending the fifth year of medical school in 1999 are described below.

Of 100 students attending the fifth year of medical school who performed activities at the General Pediatric Outpatient Clinic, 70 voluntarily answered to an evaluation questionnaire; 60% of them classified their experience with the computer-based practice as “very good”, 32% as “good”, and only 7% as “regular” (there were no “poor” classifications).

In this evaluation, students were asked to comment on their experience with the use of computers in the medical offices. Below is a list of the main manifestations; some of them contain the number of occurrences between parentheses.

– I faced some difficulties at the beginning, but at the end I got used to it (14).
– I’ll use these tools when I have my own office.
– It’s a shame that this system is only running in the Pediatric Clinic.
– It is indispensable to the future doctor (to us).
– The system provides easy access to data related to other consultations and educes bureaucracy.
– The system is impersonal, cold, and sometimes makes care more difficult; on the other hand, it provides quicker access to information and therefore discussion of cases.
– At the beginning, I found it less practical than the traditional system; now I think that it should be implemented in all clinics of the Hospital (4).
– It is practical, clean, easy, ideal for the whole Hospital. In the Pediatric Clinic, it is already a reality.
– It makes consultation, discussion, registration and access to patient information easier.

Consultations and discussions become more dynamic and organized.

It keeps the folders better organized, but I don’t see any other great advantages in the computer-based system.

Consultation takes longer, but it is the future of all outpatient clinics.

I prefer the traditional method, but I acknowledge the advantage of the computer-based system, for example: storage of consultations and security.

Histories are legible (5).

There are positive aspects - legible records, discussion improved - and also a negative aspect: it troubles the doctor-patient relationship.

It is very good, but the bugs in the network caused problems.

I’m not good at computers, but I guess I overcame this difficulty and was able to live harmonically with them. At the end, I found them useful.

The system gave us a preview of the future.

The doctor-patient relationship was not harmed.

Final considerations

The use of computer-based tools and instruments in the care provided to patients helps healthcare providers in the development of their profession, making data collection and storage and decision-making easier, and allowing for the search of the most adequate treatment, in addition to the exchange of information among doctors, institutions and patients, aimed at updating knowledge.

We emphasize that, as any other new practice, the use of the computer in the provision of care to patients causes, at the beginning, some fear or insecurity, and also raises doubts about the interference of the new technology over the doctor-patient relationship.

Therefore, it is of paramount importance that, in the implementation of a computer-based medical office, adequate training be provided for the use of these tools and instruments, both for doctors and secretaries, as well as for any other professionals involved in the process. With adequate mastering of these tools, the doctor-patient relationship is preserved.

Special attention should be given to the components related to equipment, application software and infrastructure, such as the electrical system, the computer communications network, printers, scanners, modems, and especially the patient information management software. When implementing computer-based systems in his/her office, the pediatrician should seek support for the adequate choice of equipment and software, not to mention the training in the use of the new tools.
Useful websites

Scientific research support agencies
- CNPq
  http://www.cnpq.br/
- Finep
  http://www.finep.br/
- Fapesp
  http://www.fapesp.br/

Pediatric decision support
- Isabel
  http://www.isabel.org.uk/

Libraries
- Bireme
  http://www.bireme.br/
- Centre for Evidence-Based Medicine
  http://www.cebm.utoronto.ca/
- Cochrane Center of Brazil
  http://www.unifesp.br/suplem/cochrane/index.htm
- PubMed - National Library of Medicine
- Scielo
  http://www.scielo.br/
- Hon Select Integrated Search
  http://www.hon.ch/HONselect/index_pt.html

Medical Councils
- Federal Medical Council
  http://www.portalmedicoc福田.org.br/
- Dictionaries, encyclopedias and translating aids
  http://www.unifesp.br/dis/bibliotecas/webss.htm

Medical education via Internet
- UNIFESP Virtual
  http://www.virtual.epm.br/

Hospitals
http://www.unifesp.br/dis/bibliotecas/hospital.htm

Virtual hospitals
- Virtual Children’s Hospital
  http://www.vh.org/pediatric/index.html
- Johns Hopkins Children’s Center
  http://www.hopkinschildrens.org/
- Iowa Children’s Virtual Hospital
  http://www.janelal1.com/vh/docs/v0000074.htm

Public organizations
- Brazilian Ministry of Health
  http://sauve.gov.br/
- Datasus
  http://datasus.gov.br/
- Lattes Platform
  http://lattes.cnpq.br/
- CAPES
  http://www.capes.gov.br/
- Brazilian Sanitary Surveillance Agency
  http://www.anvisa.gov.br/

Pediatric journals and books
- Jornal de Pediatria
  http://www.jped.com.br/
- Pediatrics
  http://www.pediatrics.org/
- Archives of Disease of Childhood
  http://adc.bmjournals.com/
- Pediatrics in Review
  http://pedsinreview.aapjournals.org/

Free access pediatric journals (41)
http://services.epm.br/epm/bibliotecas/revistas.php?p=38

Free access pediatric books (14)
http://services.epm.br/epm/bibliotecas/livros.php?p=38

Scientific societies
- Brazilian Pediatric Society
  http://www.sbp.com.br/
- American Academy of Pediatrics
  http://www.aap.org/
- International Pediatrics Association
  http://www.ipa-france.net/
- Brazilian Medical Association
  www.amb.org.br
- Brazilian Society of Health Informatics
  http://www.sbis.org.br/

Brazilian federal universities
http://www.brazil.gov.br/orgaos/univ-fed.htm

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