Appliance and information technologies versus patient, versus physician-teacher, versus student (reality or science fiction?)

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Prístrojové a informačné technológie versus pacient, versus lekár/pedagóg, versus študent

Does it concern us directly?

Life is changing rapidly. Education in general, and medical education in particular, is changing within the large/scale transition into the 21st century. There is the incredible growing availability of reliable information. Everything is at the student's fingertips: almost everything can be learned without any teacher from easily accessible world-class resources (Benor, 2000). The revolution in education, which occurred at the end of the medieval period as a result of the invention of the printing process and establishment of open-for-all libraries, is occurring again through electronics. The first revolution moved medical education from cloisters and monasteries into universities. The present revolution further moves the learning site into the learners' homes. This process will affect not only the cognitive domain but also the instrumental or psychomotor as the virtual reality technology develops (Strava, 1999). Indeed, there will be no substitute for real flesh-and-blood patients, but the dependence of medical education upon patients will grow less and less, and the use of simulations will take over. The other aspect of current technological development, however, is somewhat inverse. It relates to the growing ability of medicine to control life, from artificial insemination to gene manipulation to cloning. Medicine will be able to control many chronic ailments and to increase life expectancy significantly, creating as a consequence a major problem of a huge aged population (Martin, Wang, 1999). All these developments will pose to medicine, and therefore to medical education, ethical and philosophical dilemmas that no remote learning from an electronic teacher will be able to resolve.

Albert Einstein said: "If at first the idea is not absurd, then there is no hope for it". His Theory of Relativity has turned our conception of the world upside-down. Should we await something comparable in a modern "communication universe and future"? Bill Gates in his beginnings said: ". . . 640 kilobytes of computer memory will be enough for anybody". Today is seems to be funny, but was not during that days.

Carel des Bos, vice-president of Alta Vista, the Internet search specialist, has called the Internet "a minefield of opportunities". The Internet is already revolutionizing our communication pattern: it no longer offers complete and comprehensive works of art or science such as literary creations or technical textbooks but just "infoids" — many small portions of text in new screen format. Individual fragments of information (zero-one-zero) freely float in the Infonet. It is up to us how we connect these "infoids" - and it does work, actually. Siegfried Meryn (1998) said: "knowledge is the capital of the future". And there is no power to stop the globalization like IT are.

To quote Stevie Smith (1957): "... I was much too far out all of my life. And not waving, but drowning." Lets try to wave.

An uncertain future - where is this flurry of activity in medical education leading? What sort of future is envisioned? The future is notoriously difficult to predict: what medical education will be like 15—20 years from now? In thinking about the future of medical education, we can adopt two different approaches. We can look at the changes taking place in medical education as a journey where the future is a continuing evolution of what has happened in the past three decades or so — an evolutionary approach. Alternatively we may visualize a more dramatic journey to a different world where there are fundamental changes in medical education, some of which we may have difficulty envisaging at this point at the beginning of the 21st century — a revolutionary approach (Harden, 2000). This may involve cutting down the oak tree, as described by Dyson (1998), no matter how painful it may be, and replacing it with something more appropriate for the needs of the 21st century.

Nowadays fiction is becoming a science, as well as a division: "to go where no man has gone before" (Meryn, 1998). "If you want to predict future, invent it", suggests John Sculley (Paris, Ayres, 1994).

Information in a nutshell — that is what we are looking for: information in the form of simple messages and pictograms that will strike our attention in the confusing chaos of things and brief-

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ly tell us what is essential (Meryn, 1998). The clearest illustration of our new communication behaviour is the Internet. None of us is able to survey its full extent, none of us knows all the information it contains, none of us can fully explain it. But many find it great. Why? Because everybody can conjure up on his/her computer screen those bits (zeros and ones) and pieces (infoids) of the universe he/she takes a personal interest. And this is also the form of information which, above all, young people wish to get. The sociological character of the "Net Generation", the successor generation to Generation X, has been shaped by the media network (Meryn, 1998).

"The future is not inevitable. We can influence it, if we know what we want it to be" (Handy, 1998).

Medical practice is evolving rapidly as new information supplants old. Gone are the days when newly graduated doctors were armed with most of the information they would need for a lifetime of practice. Today's clinicians are required to be life-long learners so that they continue to adapt to the changing ecology of the medical environment. Are our educational systems preparing doctors for this role, namely in contrast of huge investment into IT education and implementation in western countries?

Cybermedicine is a new academic specialty at the crossroads of medical information and public health. Cybermedicine can be described as the science of applying internet networking technologies to medicine and public health. Cybermedicine is global, application area is mainly primarily preventive medicine, security is limited, provides patient—patient, patient—physician, physician—physician information exchange. Cybermedicine is driven mostly by consumer pull, setting is under uncontrolled conditions, it is difficult to evaluate impact and benefit on population and the information through net is reaching millions. The quality of information is a critical factor for the use of cybermedicine. Surveys showed that important aspects of information released are reliability, accessibility, completeness of information. The resources are extremely variable, ranging from the useful to the dangerous.

Technology means applied science. Health technology is defined as the drugs, devices, and medical and surgical procedures used in the prevention, diagnosis, treatment, and rehabilitation of disease. Medical informatics include computer and information science, engineering and technologies in all areas of medicine and health care, including science, education and practice. Medical informatics consist of medical statistics, scientific medical information, laboratory/clinical/hospital information systems, medical documentation, artificial intelligency, biometry, communication, signal imaging/analyzing, simulation, modelling, algorithmization of diagnostic procedures, parameter/dosing medicaments monitoring, electronic/multimedial conferencing, telemedicine, teleconsultation, animated textbooks and atlases, clinical decisions systems, virtual reality and virtual hospitals.

Computer technology has created a dynamic environment breaching traditional boundaries. Large repositories of information have been established: multiple resources world-wide can be searched for specific occurrences of words, concepts and associations. Links, networks and dynamic associations can be established between material (text, sound, images) not necessarily stored in the same physical place, allowing students/teachers/physicians to follow the pathway of their choice through the maze and reach their own personal understanding of the domain. But the wealth of accessible material must be organised into effective learning experiences, or students risk becoming overloaded. At the same time, it is recognised that lack of factual knowledge is not generally a prime factor in therapeutic error, which more often results from problems of attitudes and skills (McWhinney, 1997).

From ancient times, the Socratic method of teaching, with an emphasis on asking student question and providing feedback on the answers, has been popular among educators. "Lecture and test" teaching methods arm learners with plenty of information but not the skills to update and replace it. Several materials were criticised for being patronising, victim blaming, dismissive, or promoting an attitude of "doctor knows best."

Whenever a new technology, such as video or computers, is introduced, many educators feel tempted to apply the latest fruit of scientific progress in the classroom, often testing it against the old techniques.

"Milestones" from Information Technologies (IT) history

1969 Internet has celebrated its 31st anniversary. First "four computer-net" connection (Universities of LA, Santa Barbara, Salt Lake City and Stanford) took place in October 20, 1969. One of Internet fathers — Leonard Kleinrock — sent a message consisted of two letters, "L" and "O", two first letter of word "LOG". Text of the report was: "Did you got L?" "Yes, I got it." "Did you got O?" "Yes, I got it." "Did you got G?" The answer for 3rd letter did not come back, the connection was interrupted. But Internet was born. Few weeks after first "moon-walker" was landing.

1970 Learning/teaching technologies include: films, tape/slide programmes, pilot computer applications, isolated examples of simulation.

1972 first E-mail message.

1982 1 000 PCs connected in net all over the world.

1985 Learning/teaching technologies include: videotape, personal computer introduced as an educational tool.

1989 Tim Bernes-Lee developed html language — a base for World Wide Web.

1992 1000 000 PCs connected in net all over the world.

1998—9 Investment in UK health-care system Information Technologies 1 000 000 000 pounds.

2000 100 000 000 PCs connected in net all over the world.

Computerised and hard copy information differ in two fundamental ways. One difference relates to perception: hard copy is something we are all familiar with and feel that we understand. By contrast, information that is stored in electronic form is mysterious and therefore a source of anxiety. Understandably, therefore, professionals and the public alike are more concerned about the security of electronic records, especially not knowing where they are stored or who controls them.

In 1999 in Brussels has been announced EU initiative — Information society for all. From priorities: 1) European youth for digital era — Internet implementation and multimedial equipment to school and to arrange the education digital era needs, 2) speed Internet for scientists and students — high-speed Internet access for co-operative learning and work, 8) health care on-line — optimal use of networks and intelligent technologies for health care. The announced initiatives are the most revolutionary from industrial revolution era and posses the global character.

The principal dilemma of the internet is that, while its anarchic nature is desirable for fostering open debate without censor-

ship, this raises questions about the quality of information available, which could inhibit its usefulness. While the internet allows "medical minority interest groups to access information of critical interest to them so that morbidity in these rare conditions can be lessened". The amount of information available to patients is increasing, particularly through the internet. For the first time in history the "layman population" has a direct access to the same medical information, at the same extent, at the same time as doctors have through IT. The quality of this information remains variable. Health professionals need to be able to direct patients to sources of good quality consumer health information, including health related websites.

The quality of medical information is particularly important because misinformation could be a matter of life or death (Eysenbach, 1999). Thus, studies investigating the "quality of medical information" on the various internet venues, websites, mailing lists and newsgroups, and in email communication between patients and doctors are mostly driven by the concern of possible endangerment for patients by low quality medical information. Thus, quality control measures should aim for the Hippocratic injunction "first, do not harm."

The basic dilemmas of Internet are: 1) "archaism" — everything entering through phone-net or satellites into our computer from anywhere is nothing more than a "brushwood of zeros and ones", 2) "anarchism" — information society powered by information technology revolution probably have a considerable impact on efficiency of future health care, consumer empowerment, public health, medical education. Internet adds a new dimension because everybody can be a publisher (quality, editorial control), originators and their credibility are difficult to assess for readers and the line between content and advertisements is often blurred (Eysenbach, 1999). Some of information can be useful, some can be a dangerous weapon.

Although computers put information at everyone's fingertips, insufficient attention has been paid to how this information is delivered. Learners and teachers are often trapped by old categories of information, automated behaviors that may cause us to miss new signals, and the inability to think from more than a single perspective. Many faculty members and students are wary of using computer-based training because of the lack of instructor/student feedback. Faculty members are especially reluctant as their medical training did not include computers, nor did they grow up with computers like the large majority of medical students did. But, who should "try to shift in mind" to the students thinking if not the teacher? The teachers have to "understand them" they are growing in information society we have "invented and prepared" for them, but "playing for a shorter hand." For us, who were not growing and maturing with IT, forgetting is more difficult, than learning. Force of old habits and tradition in our minds is very strong. Who could predict, that somewhere in "human-being genom" the "latent predisposition genetic locci" were sleeping and waiting for thousands years for information technologies invention and prepared accept them fully. There is no comparable component of humankind history to be educated so easily and fluently and naturally, like with Net Generation education in the area of IT. And starting in kindergarten, and being accepted virtually by all young generation. And understanding and chatting throughout the world, and unifying and ....

But, in addition, practitioners need to be aware of new type of addiction — Internet addiction (Young, 1998). The Internet is a neutral device originally designed to facilitate research among academic and military agencies. The anonymity of electronic transactions has been identified as a consistent factor underlying internet addiction, often providing a virtual context that cultivates a subjective escape from emotional difficulties (such as stress, depression or anxiety) or problematic situations or personal hardships (for example job burnout, academic troubles, sudden unemployment). The escape mechanism provided serves to relieve moments of mental tension and stress and reinforces future behaviour.

Information, not so long ago, were a domain of "textbooks". And information "flow" was mostly "one-way" (from teacher to student, from doctor to patient). These days have disappeared somewhere in history. Medical information is often said to be one of the most retrieved types of information on web. In fact, according to survey of October 1998, 27 % of female and 15 % of male users say that they access medical information weekly or daily. Links, nets and dynamic connections join texts, sounds and (animated) pictures wherever in the world 24-hours a day. More than 120 000 medical websites exists. Internet search specialist google.com will find you any information from nearly 1 300 000 000 web pages just in seconds. In "ancient time" (7—10 years ago) it was "unpredictable, unimaginable, unbelievable".

In this communication environment, information of convincing character is of increasing importance. It is characterized by major elements: value of novelty, value of utility, emotional value, conversational value, entertainment value, express information value and in medicine it is an educational value.

Medical Schools and information technologies

Medical schools equip future doctors with some of the information they will need to practise effectively. The traditional curriculum does not ensure that they become informed consumers of medical information who are capable of finding, evaluating, and applying new information as it becomes available. To be life-long learners, doctors have to rely on new methods of learning, while caring directly for patients, by using tools that help them to hunt and forage through the jungle of information.

Medical education is poised to undergo another step in its evolution. Basic biomedical knowledge is developing rapidly, adding to the information overload already evident in traditional curricula. Humans can neither carry the entire knowledge that comprises medicine in their head, nor can they readily keep it up to date. Education is a combination of: 1) acquiring knowledge and understanding of structures and processes involved in illness, 2) mastering carefully identified hands-on skills, 3) using a logical, problem solving and reasoning process, 4) developing the ability to interact productively with up to date electronic information.

Physically, the future medical school will be a facility in which fewer and fewer hours will be spent, and which will include fewer and fewer classrooms. Instead, it will contain abundant resource centres for self-study, using sophisticated equipment with remote access from students' homes. Skill laboratories will provide endless opportunities for training, using virtual reality simulations. The time spent outside the hospital will be considerable, and may

exceed the time on the wards. Students will pace their own learning (Ludmerer, 2000).

When talking about the application of learning technologies, it is sometimes difficult to distinguish reality from science fiction. It is likely that medical education will be not different from other areas in education and virtual medical schools will be established. The idea of a virtual medical school, even a few years ago, would have seemed absurd (Harden, 2000).

Fundamental relook at medical education relates to the concept of a physical medical school. To date a medical school is thought of in terms of a physical building in one or more locations often associated with a teaching hospital. Rapid developments in educational thinking and in learning technology, however, allow us to take a very different view of the future. The Open University in the UK has proposals for a "networked" medical school based on clusters of district general hospitals and the community. Virtual medical schools will exist alongside and not in competition with real medical schools. More traditional medical schools will continue to be necessary as a base for research and for the creation of new knowledge and understanding. In collaboration it will create cost-effective and flexible learning opportunities which will allow students to study wherever, whenever and at a pace appropriate to their personal needs, backgrounds and ambitions. The virtual medical school is likely to be a hybrid campus with a balance between the "virtual" and the "visceral", combining an on-line computer-based environment with hands-on, in-person activities (Harden, 2000).

It is clear that we need a new paradigm for medical education. Simply improving the existing system may not be sufficient. We need not to reform but transform medical education (Banathy, 1991). New ways of thinking about medical education are called for. We need a new mindset (upgrade ourselves). At times of accelerated technological development an evolutionary vision of the future is inappropriate. Failure to meet the challenge and lack of a response to the technological and educational trends will alienate the medical students and the public who will have to come to expect such an approach. Everyone has a contribution to make and must accept a measure of responsibility for what happens in the future (Harden, 2000). If we will leave this challenge without an answer it can lead to graduates production, who will not be prepared and able to implement into medicine and postgraduate study powered by information technologies. The measure and address of responsible individuals for this process is clear.

What is possible technically and the pace of developments suggest that the limitations are likely to be the imagination of those concerned with planning medical education and their ability to bring about the changes necessary. We run the risk of seeing a growing gap between what is possible educationally (unlimited information amount and access) and what is delivered (Banathy, 1991).

Fascinating area for medical schools is the use of new educational interactive multimedia products in support of teaching and learning. This is especially notable at universities using for example teaching files, multimedia textbooks, image databases and Internet discussion groups, web forums, Internet Relay Chat and cool talks. There are "on-line journals" available only in electronic form on the Internet (Electronic Journal of Orthopedics, Online Journal of Current Clinical Trials). There are even more breathtaking advances with the use of the video-enhanced web integrating real-time video in hypertext documents, virtual reality simulations and desktop videoconferencing usable for virtual conferences on the Internet and for remote studies or continuing medical education. Developers at Marshall University designed a multimedia interactive patient encounter for a web server. Any physician with access to Internet can use this program to take a history, perform a physical examination, order laboratory and radiologic studies and submit a diagnosis and treatment plan. The system evaluates the user's performance electronically and delivers CME credits by mail.

Doctor-teacher and information technologies or "Doctor, where are you?"

Many doctors become frustrated, however, when they find that the skills that allowed them to excel in the classroom, and even as house officers, are of little use in their medical careers. They have learned much, but they have not learned effectively how to learn. The skills that got them through the pedagogical process are of little use when they are faced with a flood of information. No one is there to direct them towards the new information they need to learn or how to identify those pieces of their hard earned knowledge that are no longer correct. Unlike in a bakery, their loaves of information are not tagged with expiry dates. This information overload can also be a handicap, since it sets up prejudices and biases that prevent us from embracing new ideas. This shutting out of new information causes us to see the world in one, constrained way. When the only tool available is a hammer, everything looks like a nail (Shaughnessy, 1999).

There is no need to spoon feed students. No longer is the teacher seen predominantly as a dispenser of information or walking tape-recorder, but rather as a facilitator or manager of the students' learning. Sir Rhodes Boyson (1996) wrote "Too often, the teacher has degenerated into an uneasy mixture of classroom chum, social worker and amateur counsellor".

When the printing press was invented, there was concern that the printed word would give undue credibility to an idea or proposition (scientific password "publish or perish"). The same applied to the world wide web when it started, although people now have a healthier scepticism for anything on the web because of the rapid growth of electronic junk. However, the web is an important mean of communication, and will become increasingly important when it becomes available on digital television. The arrival of the world wide web has given us the chance to rethink the trade offs that have traditionally been made in scientific publication. Previously, we have accepted that the benefits of quality control have outweighed its costs. These include the long delays between the completion of research and its publication, the random scattering of articles on similar topics among journals of varying accessibility, and the loss of some articles (not necessarily the worst) from the system completely. Meanwhile, the price charged for this value adding service is rising faster than most customers can afford.

While it is a safe prediction that technology will play an increasingly prominent role in education in the years to come, cynics will argue that, until recently, computers and other learning technologies such a videotape and film have had a disappointing impact in education being not able to replace a teacher role. "Wave after wave of technology reform in education has left many unful-

filled promises" (Kent-McNergney, 1999). But technological wave after technological wave is rolling.

There is no longer an absolute requirement for many of the restrictive aspects of curricula — such as fixed timings of courses and progression rates, synchronous physical attendance in a classroom, and sequential access to specific books or journal articles. A world of up to date information is available on line to anyone, including patients, with a personal computer, web browser, modem, and telephone line.

Previous independent disciplinary courses presented lectures and made assessments using instruments that stress memorisation of material by rote. The clinical years present a "reductionist" model of the body as a machine with organs that can be repaired by specialists in that organ system. Newer attitudes to curriculum emphasises understanding mechanisms of disease as they relate to clinical problems, with teaching by problem based learning methods that promote life-long, independent learning and integration across basic, social, population and clinical sciences. Problem based learning is, by its very nature, patient centred and holistic, presenting the component sciences in the context of their practical application. So what is "education" — education for what? Traditionally, emphasis has been on mastery of a body of biomedical knowledge and skills deemed essential for competent practice. Today, however, practitioners must continuously access and apply up to date information and diagnostic and therapeutic protocols to their practice. The paradigm has shifted (Harden, 2000).

The teacher should act as a facilitator (Harden, Crosby, 2000). The teacher will agree learning contracts with the students, help students to plan their learning, advise students on accessing appropriate learning opportunities on-line and in person. The computer too will function as a facilitator as well as a tutor. "The day of the multimedia computer", suggest Gibbons and Fairweather (1998), "will turn into the day of the instructional companion computer. When you will use it, you will not be alone. You will have not only a responsive companion in the learning process, but that companion will remember you from experience to experience. It will remember your style, your preferences, and your learning goals. It will help you reach those goals by suggesting experiences which lead toward them. It will also be able to influence those experiences as they occur, tailoring them to your methods of learning and your prior knowledge." There will be on-line socialization through live instructional sessions. At these sessions, presentations and discussions using videoconferencing facilities will allow students to meet experts both locally and internationally, and groups of students in other settings. Such videoconferences, at some time in the future, will move from two-dimensional television to three-dimensional holographic television technology. This will be particularly useful when watching surgical and other practical procedures. Students' mastery of practical procedures will be watched and monitored by experts at a distance using equipment developed with a computer interface and computer-generated simulations. Students will have access to a wide variety of resources through the Internet including databases, information banks, libraries of books and journals, on-line experts and on-line courses. While working in the clinical setting, students will remain connected through the Internet to the learning resources, expert advice, their tutor and their peers.

The same process that will make teachers "redundant" to some extent in both the cognitive and the instrumental domains, will make them more crucial than ever as far as the affective domain is concerned. Teachers will be required to "transfer" less knowledge and skills than today, and act more as cultivators of proper human relationships and as moral guides (Benor, 2000).

The developments in medicine will put an ever-growing burden upon physicians' shoulders. There will be more to know, more to master, more powerful equipment to operate and more issues to address. Under these conditions one cannot avoid asking who the future medical teacher should be, able to teach the student not only his or her clinical disciplinary knowledge and skills, but also how to manage cases and how to relate to human beings.

The other role of teacher, which is presently a secondary mission in spite of much rhetoric, is moral guidance. A lot of effort will be needed to educate a humane physician who can relate to another human being as a whole. Moreover, much effort will be needed to address the emotional and psychosocial problems of life, which will prevail. No less attention will be required to relate to the student's own anxieties, dilemmas and ethical uncertainties, which will be incomparably more frequent and more solemn than today. The fast-moving, mechanistic world into which we are drawn will not enable "by the way" learning of human contacts, doctor-patient relations and handling of dilemmas (Benor, 2000).

The teachers will no longer be expected to convey information. Teachers who try to remain in the present position as the primary source of knowledge, and who will not be able to say "I do not know, let us look it up", will not survive. Good teachers means "well-organized, well-prepared, interested in the subject, friendly, flexible, helpful, creative, clear, enthusiastic, interested in students, open, systematic, committed — and IT oriented and skilled". The future medical teacher will have to be able to guide the student through the moral and emotional labyrinth of future life. He, or she will have to be able to manage emotional crisis situations of both patients and students. One may just argue that this profile of the future medical teacher calls for an "angel like", supernatural human being. Moreover, these super-humans will be functioning in a cruel, mechanical and cynical world (Benor, 2000).

Student and information technologies or "Student, where are you?"

One good example of "Net Generation" education is the Alameda cyber school in San Francisco where technology is used by the students to direct their own studies. Teachers have a different role from that in traditional schools and act as facilitators, meeting with students only twice a week. Pupils have found such a cyber school an effective learning environment and the achievements of the students are impressive. Projects undertaken by the 11—year-old students, such as making solar-powered scooters, go well beyond what is normally expected. New school in Scotland will allow students to work in virtual science laboratories. The main open-plan learning plaza has computers that allow pupils in Scotland to work with groups of children living in the rainforest in South America as part of geography lessons and to participate in Spanish lessons taking place in Spain. Those who are not able to attend can take part in lessons from home. Keir Bloomer, director of education in that school concluded that the era of the "Virtual Secondary School" was just around the corner. He said "The younger of you at least, will finish your careers not as managers of

institutions, but as brokers of experience". "We have reached a point where education can take place anywhere and at any time and the secondary schools as we are used to may almost disappear" (Sunday Times, 19 March, 2000). And the graduates of these school can apply for medical faculty studies in a short time.

But many graduates leave medical school today financially poorer and often little enriched cognitively. They are generally weighed down under a vast burden of obsolescent information, the important elements of which could be found by an intelligent member of the lay public faster and in an updated form directly from the world wide web. Students are also changed culturally, not necessarily for the better. Their time spent studying in the academic ivory towers, from which most graduate, separates them from their community roots and also reinforces the divide between primary and secondary care and does little to emphasise the essential humanity and caring intrinsic to this vocation (Neame et al., 1999).

Learning and developing competency in medicine is a little like running a bakery. We begin our medical education by having professors and teachers stock our empty shelves with new "loaves" of information. We, of course, do all the heavy lifting the actual learning to get this information onto the shelves, but our teachers are always there to tell us what bread to stock and what to do with it. People who are good at "stocking their shelves" with information given to them by their teachers make good medical students. They excel in school and perform well on tests. They become expert at storing the right answer on their shelves, ready to pull it down when the question comes up in the examination (Shaughnessy, 1999).

Medical teachers will no longer be perceived by students as "gurus" whose wisdom is irreproachable. Students will question everything, they will also have the opportunity to check, examine and verify their teacher's teaching, their institution's policies and their preceptor's clinical solutions. Moreover, future students will be fully aware of their right to develop their own potential to its maximum, will not hesitate to demand it, and will know quite well how to achieve it. The same equalizing process that brought physicians down to the level of their patients from the pedestal upon which they had stood for centuries will eventually happen to medical teachers (Benor, 2000). "Managed medical education is around the corner, whether we like it or not" (Hafferty, 1999).

Existing methods for traditional or lecture based learning methods assemble lecturer and students in a single pace. By contrast, new technologies allow students to proceed at their own pace and create flexible learning environments. Advanced web technology allows programmed access to learning modules and tests. "Virtual" tutorials are conducted by threaded discussion groups. These methods hold great promise for allowing lifelong learning through accessing up to date electronic knowledge resources on the web and CD Roms.

Preparation of students for encounters with patients may involve interactive simulations, models, and computer based simulators. The acquisition of some skills will still require apprenticeship — such as learning to interact with and examine patients and to perform physical procedures and developing humanistic and caring attitudes. These skills can be acquired wherever there are competent care providers able and willing to impart them. Indeed, at present students are dispatched to various locations of primary and secondary care on attachments, rotations, and electives to develop these skills in the same way. The new paradigm will improve equity of access to the best educational experiences for all students and will appeal particularly to certain types of student. Students from rural and remote community backgrounds will be able to study within the social and clinical context of their community, so increasing the probability that they may remain there to practise. Communities will welcome graduates who are community oriented and appropriately skilled in up to date, evidence based information. The patient centred, problem based focus of their study programmes and the person based approach of their apprenticeship will give graduates an appropriate background for assisting patients to manage their own health risks and to assume responsibility for and control over their own health care.

Decentralized studies will allow the individual student to develop his or her professional skills at his/her own pace, choosing a preferred modality for learning. This necessitates a strong quality-control mechanism. Repeated tests, examinations, quizzes and other evaluation measures will take a greater part of teachers' time and energy than ever before.

There is some concern that learning at a distance will remove the human touch from education. Socialization can be achieved through students working in groups and systems have been demonstrated in which the teacher is teleported to distant classrooms using a conferencing system that transmits hologram-like images of the teacher over high-speed Internet connections. The lifelike image of the teacher allows the teacher to look at the students and interact with them as if he or she were there in person. There is also concern as to whether staff are ready to accept the concept of virtual university. "Pressure on education institutions to use these new instructional technologies", suggested Ely (1999), "will sometimes outstrip the ability of educators to revise their approach to teaching. This will lead to massive teacher training, professional development".

One can begin to see a future for education that offers students a high quality service within they develop relevant knowledge, understanding, and skills at a competitive price and with effective and efficient educational strategies. The educational vehicle must be convenient for students, promoting flexibility and enabling the students to study anywhere convenient, in their own time, with non-threatening self assessment. Opportunities for online self-assessment will be a key feature of the learning environment and students will be able to chart their own progression to the achievement of the exit learning outcomes on the basis of performance in simulated exercises. Students will browse and search these resources to locate interesting information, exploring virtual anatomical, histological, medical, surgical, and pathological specimens, images, and procedures on their PC in colour and with 3-dimensional appearance. Investments in buildings and classrooms for study will be reduced, as will the need to remove students for long periods from their community to centres of academia. The need for physical access to materials such as cadavers, specimens, and journal articles will be largely eliminated. Interactive, low cost web sessions will link experts with students in different locations. Software will serve the successive components of a course directly to the students when and where they may require it.

And how does it look like at Hi-Tech medical schools or in postgraduate centers. A new generation of highly sophisticated computer-driven realistic simulator devices has extended the en-

velope and complexity of tasks and procedures that can be modeled for education, training and research. These tools invest static models with rich audiovisual and touch/feel interactive cues, and build on powerful software for teaching, learning and assessment. The well-known Harvey Cardiology Patient Simulator presents auscultatory and pulse findings of 27 cardiovascular conditions and supports a comprehensive curriculum. The Harvey simulators are mostly used for teaching medical students bedside clinical skills. Transferability to actual patients of skills learned on Harvey has been demonstrated (Jones, 1997). Another recently available tool is an ultrasound simulator that appears and operates like an actual ultrasound system with a fully functional control panel, transducers and a realistic patient-manikin (Meller, 1997). The system includes performance assessment features and a built-in instructor, and is accompanied by an extensive library of clinical cases. These ultrasound simulators are increasingly used by radiology, emergency medicine, surgery and obstetrics-gynecology training programs. Minimally invasive surgical procedures are ubiquitous, and have introduced demands on surgeons to develop new skills. Operating through laparoscopes, while viewing surgical fields on video screens, requires special hand-eye coordination and the ability to operate with reduced feel/touch feedback. Several laparoscopic high-tech surgery task trainers are becoming available (Nick et al., 2000, Gallagher et al., 1999, cine-med.com, 2000, limbsandthings.com, 2000). Manipulation of the surgical tools in the most advanced models under development moves hidden sensors that register force and direction. In the endoscopic arena, similar technology has been applied to create tools of increasing fidelity for gastroenterology (simbionix.com, 2000), arthroscopy (Mabrey et al., 2000), endoscopic sinus surgical procedures (Rudman et al., 1998). Many other high-fidelity task trainer simulators are already available (denx.com, Rose et al., 1999), interventional cardiology (Cotin et al., 2000). Virtual reality can be defined as "a system that enables one or more users to move and react in a computer-simulated environment". Technically true virtual reality refers to totally synthetic environments, where cues for all senses are computer generated. The Visible Human Project (VHP) has been an important resource for many educational programs and device development. The VHP digital database available in the public domain consists of a fully imaged man and woman using multiple formats (CT, MRI, photographs). The Next Generation Visible Human supports higher resolutions in three dimensions, and is already incorporated in simulation initiatives in head and neck and orthopedic surgery. The Virtual Human Initiative is expected to create the human simulation environment of the 21st century — an integrated system of biological and biophysical models, data and computational algorithms, supported by advanced computational platforms. This simulation is expected to have both clinical and educational applications that will radically change the face of medical training and procedural medicine during this century. Computerized realistic patient simulators have been now commercialized (medsim.com, 2000, meti.com, 2000). Realistic patient simulators (RPSs) are advanced in the number and detail of the features they possess. The common features include a full-length manikin, a computer workstation, interface device that actuate manikin signs and drive actual monitors. RPSs have eye responsive to light, pain and selected cranial nerve palsies, an anatomically correct and dynamic airway, patient voice, arm movement, heart and breath sounds and excretion of carbon dioxide. Chest-tube insertion, monitoring of neuromuscular transmission using standard nerve stimulator devices and provision of dynamic physical cues mimicking extremity compartment syndrome are supported features. Physiologic computer models of ventilation, gas exchange and cardiopulmonary function interact with pharmacological models which can simulate actions of dozens of agents administered by various routes. The internet will change radically in the coming millennium. The next generation internet (http://) will operate at speeds up several times faster than today.

From the patient's perspective, simulation technologies and databases used for learning/teachnig (www.medsim.com; www.meti.com; sophusmedical.dk) reduce the exposure of patients to health professionals that are less experienced, and thus contributes to better protection of patient rights to receive quality care that focuses on the patient's need rather than care compromised by training needs. Patients are to be protected whenever possible and are not training commodities. Conflicts with patients' needs to avoid errors in care are eliminated, as well as the accompanying stress on trainees. With live patients, learning time is limited, access is sporadic, and the "fit" of the learning experience to the trainee's level and needs is often suboptimal. Whereas the apprentice method and learning from actual clinical encounters are constrained by chance, availability, and conflict with clinical operations, simulation-based education provides the opportunity to have full control over the clinical curriculum in terms of content, degree of difficulty, sequence, clinical setting and the variety of clinical scenarios. Simulation-based education enables application of a very effective educational principle: learning from mistakes and "never ending repetition". Simulation allows physicians in training to take risks, to go further in procedures than would be allowed with live patients, and to make errors without penalty. Because mistakes made during simulated exercises do not cause harm to living patients, they can be reviewed openly without concern of liability, blame or guilt.

Patient and information technologies or "Patient, where are you?"

Questions commonly asked by patients: what is causing the problem?, am I alone?, how does my experience compare with that of other patients?, is there anything I can do myself to ameliorate the problem?, what is the purpose of the tests and investigations?, what are the different treatment options?, what are the benefits of the treatment(s)?, what are the risks of the treatment(s)?, is it essential to have treatment for this problem?, will the treatment(s) relieve the symptoms?, how long will it take to recover?, what are the possible side effects?, what effect will the treatment(s) have on my feelings and emotions?, what effect will the treatment(s) have on my sex life?, how will it affect my risk of disease in the future?, how can I prepare myself for the treatment?, what procedures will be followed if I go to hospital?, when can I go home?, what do my carers need to know?, what can I do to speed recovery?, what are the options for rehabilitation?, how can I prevent recurrence or future illness?, where can I get more information about the problem or treatments?

Many materials on Internet network included prescriptive statements and lists of "do's" and "don'ts" that were not supported

by evidence. It was very uncommon for materials to admit to scientific uncertainty or variations in clinical opinion. Very few contained any information about the primary sources on which they were based, and it was rare to find a discussion of the strength of research evidence for the claims made. It is very important that patient information is based on the best and most up to date information available. Reliance on the knowledge of individual doctors is not sufficient as a guarantee of reliability. The content of reliable information: 1) Use patients' questions as the starting point, 2) Ensure that common concerns and misconceptions are addressed, 3) Refer to all relevant treatment or management options, 4) Include honest information about benefits and risks, 5) Include quantitative information where possible, 6) Include checklists and questions to ask the doctor, 7) Include sources of further information, 8) Use non-alarmist, non-patronising language in active rather than passive voice, 9) Design should be structured and concise with good illustrations, 10) Be explicit about authorship and sponsorship, 11) Include reference to sources and strength of evidence, 12) Include the publication date.

Interactions with patients are also changing. The biomedical literature is readily accessible to patients, and doctors will frequently find themselves working through information from websites alongside their patient and other members of the therapeutic team, acting more as analyst, synthesist, guide, and the voice of experience rather than as the source of knowledge.

The goal of medical education "for patient disease and complaints" must therefore be redefined broadly along the lines of Ludvigsson, 1999. 1) understanding biomedical concepts related to disease mechanisms and evidence based, 2) developing interpersonal and hands-on skills, including forming productive partnership with patients and healthcare team members and demonstrating appropriate professional values, 3) applying a logical reasoning process to solving individual or community problems and to critical review of new information, 4) accessing information resources appropriately to support high quality practice. These might be added a 5th point — willingness to empathise with patients' (or relatives') predicaments and anxieties.

Important aspect of extraordinary public interest and attention is patient education. Patient education is one of the most time-consuming and repetitive aspects in physician-patient communication and the provision of health care services (Sechrest, Henry, 1996). Physicians in all aspects of medicine agree that patient education is an essential part of any treatment regimen.

The role of patients in this context is to be the informed and consenting recipients of the care that is recommended and provided by doctors and institutions. Patients assume that their providers are appropriately qualified or certified and in control of any equipment used (including computers); that their personalised data will be accessible only to those who are directly or indirectly engaged in their care; and that identifiable personal information will be withheld from those who do not have a legitimate and patient centred need to know. Security remains a critical issue in respect of health information management systems: too few people understand the risks inherent in the technology, although anxiety is widespread.

Patients need information to: understand what is wrong, gain a realistic idea of prognosis, make the most of consultations, understand the processes and likely outcomes of possible tests and treatments, assist in self care, learn about available services and sources of help, provide reassurance and help to cope, help others understand, legitimise seeking help and their concerns, learn how to prevent further illness, identify further information and self help groups, identify the "best" healthcare providers (Coulter et al., 1999).

Conclusions

Medical education is entering a phase of renewed change driven by developments in information availability and technology. Over past half century medical education has remained largely isolated from the changes that have swept through most other businesses: enterprise-wide computerisation, client centred thinking, and a service philosophy.

The clients of the medical education process, who, world-wide, generally pay for themselves (though in some countries they are state funded) are guaranteed little for their money, often not even a modern, efficient, or entirely relevant educational program.

What is the future of "medicine"? Should medicine change from "reactive service" to "proactive action"? Will the medicine be "a cool medicine" (medicine dot com), or "a hot medicine" (a holistic approach to the patient, care with touches and feelings)?

I would hope that there will continue to be an important place for dedicated, caring teachers working directly with students in any future of medical education, no matter, how much use is made of IT in place of face-to-face teaching. Caring teachers, who will be able to provide students with advicing, communication skills, holistic approach to the patient and skills obtained at patient bed.

"Who in the modern age still has dreams that extend beyond the lifetimes of our grandchildren?" In the days of real IT globalization we should ask ourselves: Have we in medical education the courage and the foresight to build for the future and to chop down the oak tree, or will we be like the orchestra, that arrives for a concert with the wrong players, on the wrong day, in the wrong place and with the wrong instruments (Harden, Davis, 1998)?

New and better vaccines for preventing common conditions afflicting many millions throughout the world would be a far greater benefit to humankind than all the sensors and IT application that will be developed and manufactured in the next decade. The contrast between the upper socioeconomic classes with access to sophisticated medical technologies and the lower socioeconomic classes that continue to bear unnecessary morbidity and mortality underscore eliminating health inequities as one of our highest priorities.

Predicting the future of medical education is neither science nor an art: predicting future is a sport and as in all other sports activities the players are subject to spectators' criticism and second-guessing. In this instance, it is a case of guessing challenged by second-guessing (Abrahamson, 1996). Who was able to predict the Information Technology revolution, diagnostic/therapeutic equipment development in 1980 for the next 20 years (scientific calculators in 1980 versus information speed-highway)? "Predicting" the past is easier and more certain. Besides, the past is something that this teacher, who will retire before he sees much of the next decade (let alone century), can relate to more comfortably than the future (Schwartz, 2000). And yet many of the problems with medical education today are the same as they were in 1932,

or even earlier: to little active, experiential learning of concepts, too little problem solving, too much didactic teaching of too many facts, too little emphasis on promoting life-long learning and critical thinking skills, too little emphasis on the teaching humanism and social science to enable students to become humane and caring physicians (Benor, 2000).

As Alexis de Tocqueville wrote, after observing another wide-open community, "One must be careful not to judge newborn societies with the ideas of those that no longer exist" (Time, Digital Supplement, 1997). But there still remains the question, "quo vadis?"

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