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Information and Communication Technologies (ICT) in Medical Education and Practice: The Major Challenges

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Abstract

This literature review addresses the main effects and challenges in using information and communication technologies (ICT) in medical education and practice. **The first challenge** is to better prepare future physicians for the changing behaviours of patients, who are increasingly Internet-savvy and who sometimes appear to know more about their diseases than their physicians. **The second challenge**, which is closely linked to the first, is to raise awareness among physicians in training of the many benefits of using ICT to improve not only the quality of interventions and health care delivery but, from a broader perspective, the organization of the health care system itself. **The third challenge** is to motivate medical students and practitioners to use ICT to find information, learn and develop. It is proposed that information literacy should be a mandatory skill for all medical students. The e-learning mode of training is also addressed. Although underemployed in most medical faculties, it represents the future of initial and continuous medical training. Virtual resources and communities, simulations and 3D animations are also discussed. **The fourth and final challenge** is to change medical teaching practices.

Keywords

Medical Education, Technology, Information and Communication technology, Medical Practice

Résumé

Cette revue de la littérature présente les principaux impacts et défis engendrés par les technologies de l'information et de la communication (TIC) sur l'éducation médicale et la pratique de la médecine. Le premier défi est celui de mieux préparer les futurs médecins à l'évolution du comportement des patients qui sont de plus en plus branchés et qui, parfois, semblent mieux informés sur leur maladie que ne l'est le praticien. Le deuxième défi, intimement lié au premier, est celui de sensibiliser les futurs praticiens aux nombreux avantages que comportent les TIC pour la qualité des interventions et des soins fournis aux patients mais également, à un niveau plus large, pour l'organisation du système des soins de santé. Amener les futurs médecins à faire usage des TIC pour s'informer, apprendre et se perfectionner constitue le troisième défi présenté. La compétence informationnelle est notamment mise de l'avant comme une habileté devant impérativement faire partie de la formation de tout

médecin. La question du *e-learning* est également abordée puisque ce mode d'enseignement, encore trop peu répandu dans bon nombre de facultés de médecine, constitue l'avenir de la formation médicale initiale ou continue. Les ressources et les communautés virtuelles, les simulateurs et l'animation 3D sont également évoqués. Changer les pratiques en pédagogie médicale constitue le quatrième et dernier défi relevé dans la littérature scientifique.

Mots-clés

Pédagogie médicale, Technologie, TIC, Pratique médicale

Introduction

In the words of Kofi Annan, speaking at the World Summit on the Information Society, "A technological revolution is transforming society in a profound way. If harnessed and directed properly, information and communication technologies (ICT) have the potential to improve all aspects of our social, economic and cultural life."

One of the key developments in health care in the last 25 years is the incursion of information and communications technologies (Heath, Luff, & Svensson, 2003). ICT have changed the ways in which medicine is practiced and taught. This paper examines the main challenges facing medical education in the ICT era.

First challenge: Preparing for the changing behaviours of Internet-savvy patients

One of the most important impacts of ICT on medical education is that tomorrow's physicians must be well prepared to cope with changing patient behaviours. Research has shown that patients' habits have changed significantly in recent years. Not only do they use ICT to better understand medical issues, but they also use networking to inform each other, rate their doctors, question medical procedures and launch malpractice suits. For Duvvuri and Jianhong (2007), ICT have definitively transformed the physician-patient relationship, which implies a new kind of training for tomorrow's medical practitioners. Fieschi (2002) and Denef, Lebrun and Donckels (2003) go so far as to claim that patients are far ahead of doctors in their use of the Internet to learn about medical developments, and they are sometimes better informed on their illnesses. "With the omnipresence of the Internet in homes and the growing presence of public virtual portals such as Healthgate and Medecinenet.com, increasing numbers of patients are consulting their doctors after having navigated the Web" (Karsenti, 2003, p. 232).

The literature also reveals new possibilities for physician-patient relationships, particularly when patients are isolated or away from hospital settings, such as elderly persons (Magnusson, Hanson, & Borg, 2004) or chronic disease sufferers. According to Lucas (2008), by using ICT, patients "can link with others, again using the Internet and mobile telephone networks, to share information, seek advice …" (p. 2131).

With the advent of the Internet, medical knowledge is no longer the prerogative of health care experts. A kind of democratization of scientific and medical knowledge has come about, which profoundly affects the traditional relationship between the patient, who used to be relatively ignorant, and the physician, who used to be the fount of wisdom.

This relational shift between physician and patient means that, on the one hand, medical practices have been increasingly called into question, and on the other, the status of the medical profession has been profoundly shaken (Broom, 2005).

Willmer (2007) points out that, despite the realignment of the doctor–patient relationship, the increasing use of ICT by patients and medical practitioners alike improves the quality of health care delivery in the end. Some, like the European

Commission, appear to have embraced this new patient attitude, viewing it as a way to make people more accountable for their health. Thus, better informed patients are usually more inclined to get involved in health management. "They want to be part of the health decision process and are increasingly requesting access to the data contained in their medical record" (Fieschi, 2002, p. 86). Gatzoulis and Lakovidis (2007) discuss "citizen-centered care," which requires greater patient involvement at all levels of medical practice (prevention, diagnosis, treatment and follow-up.) The arrival of ICT has caused a paradigm shift in medical practice and teaching. Greater importance has been placed on information sharing, akin to what Fieschi (2002) calls *patient empowerment*. Therefore, ICT should not be perceived as a nuisance, as many doctors do, but rather as a way to get patients more involved in managing their health. Moreover, as Broom (2005) explains, "It is argued that the ways in which these specialists are adapting to the Internet and the Internet user should be viewed as strategic responses, rather than reflecting a breakdown in their authority or status" (p. 319).

Second challenge: Raising awareness of the benefits of using ICT

The exponential rise of ICT in our society has many potential benefits for patients and doctors in the areas of health care organization and management.

Benefits for the quality of interventions and health care delivery

Along with challenges to the physician–patient relationship, this technological shift brings many benefits. For instance, using ICT, patients can readily interact with health care experts without having to leave home. Stretcher (2007) describes the benefits of software systems that can "analyze" medical situations. He also demonstrates the utility of interfaces that enable patients to communicate directly with an online health care specialist, 24 hours a day / 7 days a week. He particularly stresses the benefits of these systems for patients who, "because of stress, pain, or the cancer treatment itself, have irregular sleeping habits" (Strecher, 2007, p. 62). Medem Inc. (http://www.medem.com), a cybercompany that provides web-based physician–patient communications services, uses a similar interface so that patients can *consult* a physician online at all hours. As Norman et al. (2007) point out, the rapidly developing capacity of interactive technologies to store and transmit data multiplies the possibilities for physician–patient interaction. Physicians with access to statistical databases can consult continuously updated data in just a few clicks of the mouse. They can also communicate with their patients (and even "see" them), get more detailed information first-hand and provide better treatment.

For these reasons, the field of telemedicine, or practicing various aspects of medicine (prevention, diagnosis, treatment and follow-up) at a distance, has become increasingly common in both initial and continuous medical training (De Gara & Boora, 2006). In fact, telemedicine is gaining ground in the health care systems of many industrialized countries, including Canada, the United States, Great Britain, Germany, France and Norway (Ganapathy, 2005). The HERMES project (Casalino, 2004) in Europe is one such initiative. Telemedicine can be used to make diagnoses at a distance, to assist other surgeons in complicated operations, and to follow up high-risk patients in their own homes (Suarez, 2002). According to Suarez (2002), telemedicine also facilitates centralized pathology services, rural health care delivery, delegated nursing care, and the provision of health care in hostile or unusual circumstances. For Ganapathy (2005), a major advantage of telemedicine is that it enables diverse experts around the world to share their opinions in a few seconds and find the best solution to a particular problem. Ganapathy (2005) also suggests that specialists will soon go farther to diagnose their patients:

> Like most other professionals, the telespecialist of the future will offer advice from home without having to travel long distances to a hospital. Junior hospital staff currently depend on advice received by telephone, which has considerable limitations. Soon, using telemedicine, the senior consultant can evaluate the patient and the investigations from outside the hospital and make a correct decision. The patient's needs cannot wait for the next day's 'rounds.' (p. 852)

In addition, as Suarez (2002) explains, telemedicine enables occasional or continuous training to be offered to hospital health care specialists, who would otherwise have to leave the workplace. In the view of Sargeant (2005), telemedicine has become a highly sophisticated tool with a proven efficiency. For instance, it is a particularly effective way to teach surgery. In addition, virtual telemedicine environments that integrate the Internet and videoconferencing allow not only real-time consultations with other specialists (Loke, 2007), but also, and most importantly, continuous follow-up during surgical procedures when interns are assigned to isolated regions or foreign countries.

Finally, as Strecher (2007) points out, the use of ICT for preventive purposes is relatively limited, and it is still primarily used for treatment. According to him, this is not surprising, and it should be viewed by practitioners as a welcome challenge. The use of preventive services should also be promoted as a way to motivate citizens to be more accountable for their health management.

Benefits of improved health care organization

In the words of Lucas (2008), "There is a growing consensus that the impact of ICT on health systems will be substantial or even revolutionary" (p. 2129). Although this point is not directly linked to medical teaching, it is important to mention that several authors have underscored the benefits of ICT for health care organization. Oh, Rizo, Enkin, and Jadad (2005) extensively discuss the concept of *eHealth*, which refers to the application of information and communications technologies to the health sector, from administration to health care delivery, or alternatively, health care practice that is supported by electronic processes and communication. Of the many benefits of ICT in health care systems, Haux (2007) and Duvvuri and Jianhong (2007) note that ICT are incomparable for providing access to a vast store of information about the patient in the form of a digital file. This electronically available information facilitates follow-up, teleconsultation of the patient's file, and patient education so that patients can learn more about their condition. Duvvuri and Jianhong (2007), Ganapathy (2005), Bulterman (2003) and Fieschi (2002) stress the potential of health telemanagement for prevention, diagnoses and follow-up on chronic diseases. For example, ICT allow decisions to be made "once the parameters delivered at home have been analyzed" (Fieschi, 2002, p. 87). The Internet will only make this easier in future, and it will undoubtedly contribute to the growth of distance health care delivery. Finally, there are a growing number of handheld devices that support new and promising applications. "The work done so far has demonstrated the potential of these platforms to enable personalized care by empowering people to adopt a preventive lifestyle with an emphasis on early diagnosis" (Gatzoulis & Lakovidis, 2007, p. 51). As reported by Norman, et al. (2007), these handheld devices are increasingly being used to transmit patient information and provide better patient follow-up. For example, many portable

devices are equipped with sensors that automatically send a range of patient information to the health care specialist, with no effort on the patient's part, so that physicians can make better diagnoses and take action as needed.

Third challenge: Motivating medical students and practitioners to use ICT to find information, learn and develop

While many (De Wever, Van Winckel, & Valcke 2008; Fieschi, 2002; Hagdrup et al., 1999; Stromso, Grottum, & Lycke, 2004; Valcke & De Wever, 2006) consider that ITC should be a mandatory component in initial and continuous medical training, few initial medical training programs include an initiation to ICT applied to health care (Suarez, 2002).

The importance of information literacy

Given the vast amount of resources available on the Internet, the concept of information literacy has received much attention, particularly in the medical field. Information literacy is defined as knowledge and mastery of a variety of technical tools that facilitate access to information (websites, databases, etc.) in order to find solutions to problems that arise (Spitzer, Eisenberg, & Lowe, 1998). Kwankam (2004) sums up the importance of information literacy as follows: "ICT has become indispensable to health workers, as the volume and complexity of knowledge and information have outstripped the ability of health professionals to function optimally without the support of information management tools" (p. 800). Results of the studies by Kisilowska (2006) and Bennett, Casebeer, Kristofco, and Strasser (2004) illustrate the importance for future physicians to develop information literacy. Their findings indicate that the greatest problems facing physicians who seek information on the Internet are the phenomenal quantity of facts that are available, on the one hand, and on the other, the difficulty of finding more specific facts on certain topics.

Thus, ICT are already providing solutions to the growing need for information and knowledge sharing by today's and tomorrow's physicians. Most importantly, ICT allow physicians to stay better informed and to more easily communicate with each other. A study by Bennett et al. (2004) conducted on 3,347 physicians shows that almost all had Internet access, and that most considered the Internet important for improving the quality of care they provided to their patients. The most frequent use by far was seeking information (on the latest research or a particular disease or problem presented by a patient).

Virtual resources

There are many resources that specifically target health care professionals. Mattheos et al. (2008) attempted to organize these into categories. First, there are tutorials and other applications for computer-assisted learning (CD-ROMs, instructional websites, etc.). To illustrate, Nosek, Cohen et al. (2006) set up an instructional website targeting students in the fields of genetics and cancer (http://casemed.case.edu/cancergenetics). Black and Smith's (2002) initiative also demonstrates how online tutorials can foster better learning. However, as pointed out by Letterie (2003) and Valcke and De Wever (2006), few studies have compared the benefits of computer-assisted learning with more traditional methods. The idea here is not to denigrate the inherent advantages of using ICT, but rather to underscore the lack of research in this area. It appears that medical educators are more concerned with implementing innovations than with systematically assessing them.

Mattheos et al. (2008) report on the large number of medical databases available, the most popular being Medline. These platforms allow medical professionals to rapidly find the information they need. According to Kwankam (2004), the essential advantage of these systems and databases is that they can offset "the mind's limited capacity to sift through large quantities of health facts and identify those items that bear directly on a given situation" (p. 800).

There are also many games designed to motivate students to absorb medical lore. Although few studies have addressed this area, Valcke and De Wever (2006) point out the enormous educational potential of these tools, as they confront learners with complicated situations where they have to apply their theoretical knowledge, come up with hypotheses and test them. Immediate feedback is then provided. Sargeant (2005) provides support for this argument, contending that "computer-mediated multi-media instruction and the Internet can effectively link learners to learning materials and information resources, to each other, and to instructors" (p. 304). Several authors have enumerated the advantages of interactive online learning systems. Chan and Dovchin (2006) highlighted the benefits for medical training in so-called developing countries. Others conclude that these systems will wield a significant impact on the abilities of tomorrow's physicians to generate hypotheses (Nakamura & Lajoie, 2006), develop critical capacities (Johnson, Brose, Balazs, & DeMott, 2003; Kumta, Tsang, Hung, & Cheng, 2003), develop *reflective practice* and the provision thereof (Punja, 2006), develop metacognitive strategies (McDonald & Chalkley, 2003) and refine their diagnoses of clinical cases (Cheng, Chen, Chen, Huang, & Lin, 2003).

The studies by Charlin and colleagues (Charlin, 2006; Charlin, Gagnon, Dazi-Tani, & Thivierge, 2005) found that physicians in training could develop clinical reasoning through the use of interactive ICT applications. Charlin et al. (2005) set up an online Script Concordance test to assess the clinical reasoning of medical practitioners, residents and students in uncertain situations. Participants were asked to handle complicated or poorly structured problems that required clinical reasoning and the mobilization of a sound knowledge base. Their responses were then compared to those of a variety of experts in the field. The literature generally confirms the effectiveness of ICT-supported assessment tools and systems, particularly for active learning (Dubois, Michenaud, & Isidori, 2006; Valcke & De Wever, 2006).

Finally, a number of specialized websites are dedicated to research data. As argued by Karsenti (2003), it is important to make a wide variety of informative sources available to learners, and medical training should actively promote this. The Web also contains many sites of medical training institutions that have encouraged access to a wide range of medical information, such as the Tufts University School of Medicine in Boston (www.tufts.edu/med the University of Nebraska Medical Center (www.unmc.edu), Stanford University (summit.stanford.edu/cqi/), *l'Université catholique de Louvain* (www.md.ucl.ac.be/luc/netlinks.htm) and *l'Université Bordeaux II* (www.apprentoile.u-bordeaux2.fr/default.htm) (Karsenti, 2003). These sites also facilitate interuniversity collaboration in medical teaching (Sargeant, 2005). For Fieschi (2002), the availability of high-quality content on the Internet is a vital factor for initial and continuous training in the medical field.

Virtual communities

CD-ROMs, databases and websites are important resources for medical training. However, they usually offer limited user–interface interaction. Several studies have shown that adding the capacity to communicate and input content engenders positive outcomes, particularly in medical education (Vafa, 2006; Valcke & De Wever, 2006).

There are many virtual communities of professionals who are interested in particular topics and who regularly communicate through the Internet. Meanwhile, blogs have sprouted everywhere. These are individual, regularly updated sites that allow anyone interested to read and respond to posted messages. For example, *scienceroll.com*, *clinicalcases.org*, *healthcarebloglaw.blogspot.com* and *askdrwiki.com*, all award-winning sites, receive millions of visitors. These sites target medical students as well as practitioners. Such resources allow the exchange of best practices, best sites, recent discoveries and

the latest cures, in the aim of improving medical practice. Zobitz and colleagues (2006) reported the positive effects of an experiment conducted at the Mayo Medical School. A virtual community was created to facilitate exchanges between medical students and between teams of educators and the students. These specialized sites are not only a way to keep abreast of the exponential growth of information in the medical field, but also a way to mobilize individual and collective skills to find solutions to health problems (Kwankam, 2004).

Other popular tools are the *discussion list* and the *distribution list.* Discussion lists are usually dedicated to small groups because they allow exchanges between members. A study by De Wever et al. (2008) found that knowledge building, which is a higher-level process than reflection or the development of critical thought, is fostered by the use of electronic discussion groups in medical study programs. Distribution lists address larger groups, as they are used uniquely to transmit information and do not enable members to exchange views.

E-learning

As explained by Muirhead (2007), Harden (2006), Jones, Skirton, and McMullan (2006) and Chryssafidou and Arvanitis (Chryssafidou and Arvanitis, 2004), one of the key challenges facing medical faculties is to introduce e-learning into initial and continuous training programs. The literature reports on the many inherent advantages of e-learning, with flexibility the most often cited. Users of e-learning can proceed at their own pace, wherever they happen to be, and usually in the way that best suits them. AlRawahi (2002), Kunnath (2006), Heywood, Diers, and Heywood, (2006), Relan and Krasne (2005), Seelinger and Frush (2002) and Haigh (2004) also cite as advantages in the medical field the transmission of high-quality content, support for continuous and post-graduate education, and multiple possibilities for communicating while learning. Broader communication is another key advantage of e-learning. Castel, Figueras, and Vigo (2006) explain that "with further outreach than conventional distance learning, and taking advantage of interactivity among students and teachers in a virtual community and hypertext and hypermedia facilities, e-learning has become a useful and widely accepted tool for … training and continuous professional development programmes" (p. 788). Nevertheless, although the benefits of collaborating with ICT have been extensively exploited in other contexts (Henri & Lundgren-Cayrol, 2001), they are still underemployed in medical education (Valcke & De Wever, 2006). For instance, very little research has investigated whether this form of collaboration fosters decision-making in medical practice. One such study was conducted by Lu and Lajoie (2005). The same holds true for videoconferencing in medical education, an area that has been extensively documented in other settings: "There is a lack of literature and formal studies on the use and effects of videoconferencing to enhance real-time synchronous delivery" (Lau & Bates, 2004, p. 80).

As Harden (2006) argues, although it is difficult to accurately predict the forms that e-learning will take in future, it seems inevitable that medical students will be increasingly required to learn online. Moreover, studies conducted long before 2002 have shown that medical students are ready for distance learning (Akinyemi, 2002). It appears undeniable that e-learning is the wave of the future in medical education, despite the many problems to be surmounted and the evident lack of documentation or assessment of past experiences (Karsenti, 2003).

Virtual simulators

As reported by Harden (2006), the use of simulators has grown tremendously in the medical field in recent years. They are as effective in education as they are in practical training. Virtual simulators have been used primarily to reduce medical error (Lane, Slavin, & Ziv, 2001). The experiment

conducted by Doiron and Isaac (2002) demonstrates how simulation can reduce the medical errors of physicians in training. Using an online game, the authors reproduced an emergency room where learners had to make rapid decisions as they tried to stabilize patients and make diagnoses.

Virtual simulators represent a paradigm shift in medical education, and virtual reality is expected to play a key role in initial and continuous training in future. Again according to Harden (2006), simulations facilitate learning "through the provision of: effective feedback, repetitive practice, a range of difficulty, multiple learning strategies, clinical variation, a controlled learning environment, and individualised learning" (p. 800). In Canada, ICT are used to improve and personalize teaching methods and clinical skills, which when delivered in the traditional way, can sometimes compromise the patient's well-being (Filion-Carrière & Harvey, 2003).

The literature on virtual simulators documents the clear advantages of using ICT in medical training (Brutlag et al., 2006; Medélez Ortega, Burgun, & Le Beux, 2003). However, as pointed out by Valcke and De Wever (2006), this is particularly true when (a) neophytes are trained in the use of ICT and (b) use of the virtual simulator is not limited by lack of technological skills. Hence the importance of introducing physicians in training to these innovations at the initial training stage.

3D animations on the Web

Graphic representation of information appears to be central to the acquisition of medical knowledge (Valcke & De Wever, 2006). For some years now, medical faculties and other medical organizations have constructed extensive image banks to help specialists better understand a variety of medical issues. The literature shows that online images foster knowledge acquisition in a variety of scientific fields (Grabe & Grabe, 2004; Magoulas & Chen, 2006). In the medical field, studies have shown the importance of incorporating advanced graphic representations, particularly in e-learning, when the educator is not available to comment on the image (Valcke & De Wever, 2006). Three-dimensional animations, commonly called 3D animations, are examples of advanced graphic representations. They have the advantage of facilitating knowledge acquisition through a realistic three-dimensional visualization, which is superior to the traditional two-dimensional image. When these pedagogical resources are available on the Internet, learners and educators have the flexibility to watch them at any time, in any place, as long as they are connected to the Internet. John (2007) explains that 3D representations are particularly useful for anatomy classes, and they have shown a clearly demonstrable impact on learning, although it is evident that such resources must be used in combination with other types of pedagogical support, such as video clips, textbooks, etc. John (2007) reports that many assessments have proven the effectiveness of this pedagogical strategy. Thus, increasing numbers of medical faculties are using three-dimensional animations on the Web in initial training, for example, at *l'Université de Lyon I* in France. The concept has been pushed even further in an experiment in which educators and students can manipulate the animation, i.e. *move* it, *pivot* it, or *change its position*, at least virtually, to improve the presentation. Although the results have not yet been published in a scientific journal, the reactions of the students who participated in the experiment and were able to *move* the organs and bones of the virtual human being using a Wii remote (a.k.a. Wiimote) raise interesting possibilities for the future.[1] In addition, as John (2007) contends, the emergence of new standards and a very active user community augurs well for the future of 3D Web applications for initial and continuous medical training.

Fourth challenge: Changing medical education practices

A further challenge inherent to the use of ICT in medical education is how to implement this innovation into teaching and learning in universities and hospitals. There are many references and publications on the issues to consider in the broader area of integrating ICT into university teaching (Depover, Karsenti, & Komis, 2007; Karsenti & Larose, 2001). The literature on university teaching reveals a sort of Cornelian dilemma facing university educators (i.e., a lose–lose situation): should the content (teaching method) be adapted to the vehicle (technology), or should the vehicle be adapted to the content? (Filion-Carrière & Harvey, 2003). In fact, researchers in university education generally feel that education should be the main priority and that technology should be adapted to it. Nevertheless, recent studies have shown that teaching and learning can evolve when they come into contact with new technologies. In certain circumstances, therefore, and for specific uses, ICT can be catalysts for change. The study by Nosek, Wang, Medvedev, Wile, and O'Brien (2006) shows how technologies can be used to spur innovation in teaching practices. The authors worked with professors of very large classes who wanted to help their students engage in more active learning. The use of televoters by the participants during lecture classes fostered active learning and increased student motivation. In addition, medical students showed improved performance (in their official exams) after participating in the study. Some authors wonder whether ICT can really change physician practices on the ground and the behaviours of patients towards their diseases, which would promote improved quality of care and disease prevention (Denef et al., 2003). Ward and Moule (2007) suggest that residents could improve their practice by employing ICT during their practical training so they would know how to use ICT for their academic needs, communicate with university supervisors and improve patient care delivery during their rotations. Some go further by proposing an online management system for the training curriculum (Nosek & Medvedev, 2006).

Tools such as the e-portfolio (Lewis & Baker, 2007) inspire students and residents to use ICT not only to learn, but also to showcase their accomplishments. Thus, e-portfolios are increasingly being used not only for university training, but in medical practice as well. According to many sources, they are also a creative and effective means to organize, summarize, present and share information for medical teaching and learning and for personal and professional development.

Learning repositories (Paquette & Rosca, 2002) allow educators to quickly retrieve all kinds of useful educational materials. One of the most extensive learning object repertories is MERLOT (http://www.merlot.org/), which stands for *Multimedia Educational Resource for Learning and Online Teaching*. A free resource that imposes no copyright conditions, it was created mainly for university educators and students. Among other things, it offers peer-reviewed teaching materials: animations, lesson plans, assessment methods, etc. However, as rightly pointed out by Valcke and De Wever (2006), no scientific assessment of the effectiveness of such resources has been published to date.

Conclusion

Medical education institutions need to better prepare medical students for the changing behaviours of patients, who are increasingly connected to the Internet and sometimes better informed on their diseases than their physicians. Physicians of the future must be prepared for the new reality. The idea is not to limit the information to which the patient has access, but rather to use these new skills as leverage to make patients more accountable for their health, also known as patient empowerment.

ICT offer many opportunities for improving the quality of interventions and care provided to patients and for better organizing the health care system. They should improve the physician–patient relationship as well as the quality of health care delivery. Telemedicine and virtual communities of practitioners are only a few of the many benefits of ICT for improving the quality of medical practice.

Information literacy should be considered a mandatory skill in the training of all physicians. E-learning, although not yet very widespread in medical faculties, represents the future of initial and continuous medical training. Tools such as virtual simulators, 3D animations, and virtual communities and e-portfolios are important innovations that will have a growing impact on medical education and practice.

Note

[1] Details of the experiment are provided at: http://www.univ-lyon1.fr/1205315796141/0/fiche___actualite/&RsH=PRAC_ACT-SER

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