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Editorial

Opportunity and Challenges of eHealth and mHealth for Patients and Caregivers

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Patient-centred care is considered as one pillar of a high-performing, high-quality health care system [1]. Innovations in mobile (mHealth) and electronic healthcare (eHealth [2]) are revolutionizing the involvement of both patients and doctors in the modern healthcare system by extending the capabilities of physiological monitoring devices [3]. On one side, it creates new opportunities for individuals to actively monitor themselves and improve their health. Indeed, a number of studies have underlined that a well-informed patient is more likely to participate in healthy behaviours and to better manage his/her condition [4,5]. As a result, patients would enjoy a better quality of life and would seek less medical attention from their doctors. On the other side, it creates new opportunities for caregivers to monitor remotely patients' health and to manage many diseases especially chronic diseases. Therefore, eHealth tools and devices, such as telemonitoring platform and mobile health applications [6], can be integrated into routine care of acute and chronic diseases and provide essential information for their management to both healthcare providers and patients [3]. A better health management could lead to greater health effects and is undoubtedly one of the key ways to reduce the number of deaths from chronic diseases. Nevertheless, although the advantages of mHealth technologies in clinical care and research settings have gradually become apparent, direct benefits to patients remain largely uncertain.

For a few years, there has been a movement linked to the emergence of these new technologies: the Quantified Self movement [3]. It is characterized by the use of wearable sensors in wireless technologies to monitor, analyse, and improve health outcomes and it exposes the motivational effect on health behavioural change of quantitative measurement and analysis of personal health parameters. Different tracking and monitoring tools that collect and analyse health and wellness data over time can inform consumers of their baseline activity level, encourage personal engagement, and ultimately lead to behavioural change. The employment of spreadsheets, Smartphone/tablet apps, and wireless monitors that log mood, food-intake, sleep, hydration level, and heart rate in the Quantified Self movement underlines the promises of mHealth technologies in communicating personal health knowledge and promoting health behaviours. In addition, a new class of patient-driven health care services is emerging to supplement and extend traditional health care delivery models and empower patient self-care [7]. Patient-driven healthcare can be characterized as having an increased level of information flow, transparency, customization, collaboration and patient choice and responsibility-taking, as well as quantitative, predictive and preventive aspects. The potential exists to both improve traditional health care systems and expand the concept of health care through new services.

For some years, wearable sensors have been successfully tested in wellness and fitness. These devices provide an opportunity for patients to meet their needs by administering information in real-time to their Smartphone, computer or other wearable devices. Besides its interest in healthy subjects, these wearable sensors have also the potential to influence patients' behaviour(e.g. feedback may motivate better self-management) [8]. They are easily managed and are becoming increasingly accurate and reliable for patient care [3,9,10]. Indeed, they could be utilized in the modern health care system as a diagnostic tool to aid in identifying and managing a lot of diseases [4]. Therefore, wearable monitoring systems can provide continuous physiological data, as well as better information regarding the general health of individuals [11]. Thus, such vital-sign monitoring systems could have important potential impact on Public Health and health-care costs through the implementation of specific disease prevention program and through improved disease management programs.

These devices have already proven their utility indifferent fields of medicine and many studies have been done, for instance, in the field of cardiovascular and metabolic health. For example, a study was conducted in postmenopausal women with impaired fasting blood glucose during 12 weeks to investigate the effectiveness of an educational intervention that used both mobile phone and the Internet to provide text messages relating to their blood glucose, blood pressure and serum lipid levels [12]. The intervention group had a mean decrease in systolic and diastolic blood pressures; no significant change in blood glucose was observed. Another study investigated the effectiveness of an educational intervention that used both the mobile phone with a short messaging service (SMS) and the Internet on the glycaemic control of patients with type 2 diabetes mellitus [13]. This intervention rapidly improved and stably maintained the glycaemic control (HbA(1)c and two hours post-meal glucose) of these patients. A similar study aimed to reduce cardiovascular risk factors in postmenopausal women with abdominal obesity over 12 weeks [14]. It showed great efficacy in reducing waist circumference, body weight, blood pressure, total cholesterol and LDL-cholesterol. A fourth study

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evaluated whether a web-based intervention by way of mobile phone and Internet SMS would improve blood pressure, weight control, and serum lipids of obese patients with hypertension during 8 weeks [15]. They found that all these parameters were improved.

The concept of mHealth has also been tested in the field of bone health. For instance, Asakawa *et al.* (2011) determined whether or not a six-month educational intervention using the Internet, to prevent osteoporosis, is able to increase bone strength in young women aged 18 to 25 compared to a control group [16]. The intervention consisted in sending emails promoting calcium intake and physical activity. The intervention group had significantly increased their calcium intake and did more exercise compared to the control group. Another study compared a group who had access to structured hip fracture prevention Web site for older adults with a group who had only access to conventional Web sites [17]. Both groups showed significant improvement in most outcomes (knowledge, self-efficacy, exercise). For calcium intake and satisfaction, only the intervention group showed an improvement. A third study randomized 121 women to receive either personalized Internet-based tutorials with behaviour modification strategies or standard information [18]. The intervention group significantly increased their general knowledge about osteoporosis and calcium compared to the control group. Contrariwise, intervention participants were not significantly more likely to meet recommendations for behaviour changes. However, later analyses showed that participants desired more information to learn exercises, especially in the form of videos or illustrations. They also reported that they would be motivated by testimonials and participant success stories. Therefore, tailored strategies may improve knowledge and ability to meet health recommendations [19]. Such interventions could be used in menopausal women with current osteoporosis risk to decrease the burden of osteoporosis.

These new technologies have also been used in the field of neurology. For instance, in 2009, a study used two different sensors, one placed on the lower back and another placed just above the right ankle, to monitor gait in children with cerebral palsy [20]. It is essential to analyse the atypical gait in children with cerebral palsy to be able to assess whether independence in daily living is possible. The study demonstrated the accuracy of these activity monitors for assessing the distance walked and the step count in typical developing children and children with cerebral palsy. Although gait laboratories able to analyse gait in this kind of population exist, the possibility to predict gait in other surroundings remains understudied. Therefore, these devices can provide a possible means of objectively comparing the differences. Trying to reassure caregivers of patients with epilepsy, another study determined if a wrist-worn motion detector could detect tonic-clonic seizures [21]. Individuals admitted for continuous video/EEG monitoring wore a wristwatch-size device that was programmed to detect rhythmic movements such as those that occur during tonic-clonic seizures. When such movements were detected, the device sent a Bluetooth signal to a computer that registered the time and duration of the movements. Recorded detections were compared with the routinely recorded video/EEG data. Seven of the eight seizures were detected. Only one false, detection occurred during sleep. In principle, this device should allow caregivers to be alerted when a seizure occurs. Accelerometers have also proven to be reliable and objective devices to monitor the free-living physical activity of 40 stroke patients [22] but also to diagnose Alzheimer's disease more effectively than current methods [23,24]. Indeed, in a blind analysis comparing patients with Alzheimer's with healthy patients, researchers were able to discern Alzheimer's patients from healthy control subjects 91% of the time. This device has proven effective tool in Parkinson's disease [25,26]: a project assessed mobility in patients with Parkinson's disease, with the use of wearable sensors [27]. Healthy adults and patients with Parkinson's disease wore a triaxial accelerometer on their waist during short walks. The average stride time was greater for the Parkinson's disease patients than for the controls, and the walking patterns of the Parkinson's disease patients were less consistent. The authors concluded that frequency-based measures and sensitive estimates of stride-to-stride variability could serve as an objective, easily calculated marker of gait variability in real-world settings.

Several studies explored the benefits of Internet use during pregnancy. It has been shown that most women use the Internet to supplement information already provided by health professionals and many of them used it to help them with their decision making. Indeed, some women reported dissatisfaction with information given by professionals and lack of time to ask them questions [28]. Some of them also go on social network or chat room to talk about their problems which may appear "taboo" like postpartum depression [29], miscarriage [30], etc. Another study evaluated the efficacy of an intervention combining videoconferencing and telephone contact compared to standard post-partum care of recent mothers attending health centres [31]. Authors found that virtual care via videoconferencing are effective for post-partum women. It reduces the number of health centre visits and allows mothers to consult health staff immediately and from their own home.

In summary, in recent years, Internet has become one of the most important sources of health and medical information for patients. It is often the first step in checking for basic information about a disease and its treatment. Nevertheless, the use of the Internet by patients can be interpreted as a resource promoting their independence but also as a source of anxiety and disturbance in the doctor-patient relationship. This is especially true with the emergence of all the new technologies and the possibilities that they offer to patients. Although healthcare providers are always trying to increase patient's autonomy and to create a harmonious relationship between physicians and patients, endowed with this technology some patients could erroneously disregard the role of the physician [3]. This could be averted by patient education and comprehension of the limits of this technology. Indeed, these new technologies are more and more widespread, accurate, objective and reliable. They could be potentially good solutions in the management of a myriad of diseases. However, further targeted studies are needed to define the exact role of these tools in the management (i.e. prevention or treatment) of diseases. At last, the role of caregivers towards these technologies must be clarified but should not be neglected.

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