E-Health and Telemedicine: Current Situation and Future Challenges

Prof. SANER HUGO

Preventive Cardiology & Sports Medicine University Bern University Hospital, Switzerland

Demographic changes, progress in medicine technology and regional problems to provide health care to low density populations are posing great challenges to our health systems. Rapid progress in computer sciences and informatics technologies will have a great impact on the way health care will be delivered already in the near future. This article describes chances and challenges of e-Health and Telemedicine in the framework of our health systems and in particular of today’s cardiology services. The most promising applications of e-Health and Telemedicine include: 1. prevention and lifestyle interventions; 2. chronic disease management including hypertension, diabetes and heart failure; 3. arrhythmia detection including early detection of atrial fibrillation and tele-monitoring of devices such as pacemaker, ICD, and implantable rhythm monitoring devices; 4. tele-rehabilitation.

An important challenge for those involved in these new technologies will be to keep the main focus on patient’s individual needs and to carefully evaluate the evidence behind the practice.

Introduction

Our health systems are facing great chances and at the same time great challenges. This is due to demographic changes, progress in medicine technology and regional problems to provide health care to low density populations. Furthermore, due to the increase of life expectancy and the increasing number of elderly people, there is an increasing need for the treatment of chronic diseases [1, 2]. E-Health and Telemedicine as they are today, are not only seen as a supplement to the classic health delivery methods but will be integrated into private and public health economy as a main component of modern healthcare. Progress in eHealth and telemedicine is not only driven by health economic factors but in particular by the breathtaking speed of progress in computer sciences and informatics technology (Table 1).

However, there are major obstacles to the integration of e-Health and telemedicine into daily clinical practice: First of all, the evidence base for the value of e-Health and telemedicine in managing a wide range of cardiovascular disease is, on the whole, still weak and contradictory. Furthermore, the development of e-Health and telemedicine is still primarily technically driven and not by the needs and expectations of the clinically active health professionals, and third, common platforms and connectivity between tools and systems are mostly lacking. There are inherent uncertainties of such systems and there are major issues in the area of privacy and data protection. Last but not least, there is a lack of business cases, cost efficiency calculations and regulation of reimbursement of e-Health and telemedicine which at the end may turn out to be one of the biggest obstacles for the introduction of evidence based e-Health and telemedicine tools into the health delivery system (Table 2).

E-Health

The term e-Health encompasses a range of services or systems that are at the edge of medicine/healthcare and information technology, including:

- Electronic Health Records: Enabling the communication of patient data between different health care professionals (GPs, specialists, etc.);
- Telemedicine: Physical and psychological treatments at a distance, including telemonitoring of patient functions and information from patients with devices such as pacemakers and internal defibrillators;
- m-Health: The use of mobile devices in collecting aggregate and patient level health data providing health care information to practitioners, researchers and patients, real time monitoring of patient’s vital signs and direct provision of care (via mobile telemedicine using smartphones, mobile applications (apps)), social media, analytics and e-Cloud;
- Medical research using data mining and machine learning by powerful computing and data management capabilities to handle large amounts of heterogeneous data.
- Other forms of e-Health include consumer health informatics by the use of electronic resources on medical topics by healthy individuals or patients, health knowledge management e.g. in an overview of medical journals, best practice guidelines or epidemiological tracking, virtual health care teams consisting of health care professionals who collaborate and share information on patients through digital equipment and health care information systems such as software solutions for appointment scheduling, patient data management, work schedule management and other administrative tasks surrounding e-Health.

Telemedicine

The term «telemedicine» has a wide definition and is considered to be medicine practice at a distance and corresponds to a wide range of telemedicine applications. Telemedicine interactions have been of two types, either taking place in real-time such as for video conferences, or asynchronously such as store and forward transmission of data from a monitoring of home-based measurements of body weight, blood glucose, blood pressure, and others. Mobile applications may be either automatic...
(e.g. passive monitoring of activity using room sensors) or require the patient to do something (e.g. transmitting home-measurement values using conventional telephones or increasingly and in particular smart phones). Educational applications depend on web access from PCs or smartphones and are increasingly applied in medicine for distant learning and information. This application will turn out to be particularly useful for primary and secondary prevention of cardiovascular disease. Therefore, it is not surprising that telemedicine is an emerging issue in telemedicine. Another important application includes remote control of devices such as internal cardioverter defibrillators (ICD) and/or pacemakers. Transmission of data from the device to a central database with the opportunity to survey patients’ data and in particular heart rhythm with the benefit to increase patients’ safety and hopefully also comfort. However, the evidence-base for the value of eHealth and telemedicine in managing a wide range of chronic diseases is still weak and contradictory. The most promising applications of remote patient monitoring include prevention and lifestyle interventions, control of hypertension, diabetes and heart failure, arrhythmia detection and telerehabilitation (Table 3).

**Prevention and Lifestyle Interventions**

Cardiovascular Prevention is the most important intervention in cardiology economically and carries the greatest potential to reduce the burden of cardiovascular disease. Monitoring of cardiovascular risk factors seems to be particularly appealing for the use of telemedicine and in particular health applications to improve lifestyle and adherence to pharmacotherapy by surveillance, education, psychological support, and interactive motivational tools i.e. to improve physical activity, healthy nutrition, and smoking cessation and by this reducing metabolic risk factors and improve cardiovascular health.

There are several studies in the area of telemonitoring and self-management in the control of hypertension [3—5]. They show that monitoring blood pressure at a distance is effective and therefore is one of the most promising applications of telemonitoring of cardiovascular risk factors in primary care. However, results in regard to outcome and in particular in regard to cost-effectiveness are either controversial or lacking. Telemonitoring and self-management of diabetes is also an area of great interest. Research is somewhat less advanced in this area compared to blood pressure control. And reliable results in regard to feasibility, effects on blood glucose control, prognosis and cost-effectiveness are not yet available.

Smartphones are of main interest to be used for preventive and rehabilitative interventions at a distance. However, potential pitfalls and perspectives of acquisition and analysis of cardiovascular signals on smartphones have to be kept in mind. As mobile devices and applications such as apps entwine in our daily practice and affect already profoundly the way we conduct business, form and maintain relationships, seek relaxation and entertainment and more recently acquire information about our health, their use and application seems to be more consumer driven than governed by health professionals. Therefore, it seems timely to get a closer insight into challenges and opportunities using mobile devices in the context of health and medicine [6—9].
Furthermore, there are open questions in regard to liability: What are the responsibilities of the patient, what kind of action has he to take under specific circumstances such as potential dangerous measurement results and what is the task and responsibility of the telemedical center being in charge of data surveillance? Which algorithms should be best used for big data management and for alerts in case of emergencies? Who is paying for what in such a telemedicine system? And will it improve outcome and save money long-term?

**Early detection of arrhythmias**

For a long time, remote control of heart rhythm is of interest for prevention of sudden death due to ventricular fibrillation in patients at risk and in patients with devices such as ICDs, pacemaker, RCTs and implanted monitoring systems. Another emerging and most promising application of remote control of heart rhythm is early detection of atrial fibrillation (AF).

AF is the most common clinical arrhythmia, which is responsible for at least 15% of strokes, and is the leading cause of stroke among patients >75 years old [10—12]. Moreover, strokes due to AF are largely avoidable, as the use of oral anticoagulants along with the diagnosis and treatment of hypertension, can prevent >65% of all strokes. Therefore, early detection of AF, assessment of stroke and bleeding risk, and beginning of appropriate prevention are most important components of healthcare not only to reduce the burden of disease but also to reduce health costs [13, 14].

**Telemedicine in Heart Failure**

Heart Failure (HF) remains a large medical problem. And prevention of decompensation and HF-related hospitalizations is important not only for the patient, but also from economic point of view. Close monitoring is crucial and can be done through various modalities. This monitoring ranges from a (nurse-based) disease management program, to structured telephone support, to remote or telemonitoring with or without the use of implantable devices [15, 16].

Remote, home or telemonitoring using a number of (relatively simple) noninvasive variables such as heart rate, blood pressure, and body weight was also examined in a number of studies, and a meta-analysis showed that this method reduced both hospitalizations and mortality [17].

Feasibility and perception of telemedical care by patients and physicians has been studied in the framework of the TIM-HF trial with the objective of proving the superiority of remote patient monitoring compared to guideline-based usual cares in terms of total mortality, heart failure-hospitalization, quality of life, and other markers of cardiovascular health [18]. Two telemedical centers — located in two German regions — provided physician-led medical support for 24 h/day, 7 days a week, according to defined standard operating procedures. Patients were enrolled from 165 practices in cardiology, internal medicine, or general medicine, and followed for at least 12 months with several outpatient visits. Results are encouraging, showing the feasibility of telemedical care and a good perception by patients and physicians.

For recently hospitalized patients representing 1/6 of the total heart failure population, application of telemedicine surveillance and guidance has led to a reduction of mortality [19], a 30% reduction of heart failure hospitalisations and improvement of quality of life [19, 20].

**Remote monitoring of patients with devices**

The implantation of electronic cardiac devices has increased substantially over the last decade. Subsequent monitoring is an integral part of both device and patient care. Traditional practice has followed an in-clinical follow-up by physicians and/or device specialists to retrieve stored diagnostic data. This generates an enormous clinical workload which increases further when devices approach ERI, or in response to product advisories and recalls. The application of e-Health and Telemedicine for remote monitoring of patients with implanted devices may provide mechanism(s) for facilitating these tasks [21—35]. Data are promising and it can be expected that remote monitoring systems will develop into dedicated monitoring and therapy platforms. We expect that data retrieved from these systems will form an integral part of the electronic patient record in the future as more and more outpatient clinic care will shift to personalized care provided at a distance, in other words at patients’ homes [36]. A provider perspective in five European countries on costs and net financial impact of follow-up with and without remote monitoring indicates, that for all patients as a whole, follow-up related costs for providers are not different for remote versus purely in-office follow-up, despite reorganized care. However, disparity in the impact on provider budget among different countries illustrates the need for proper reimbursement to ensure effective remote follow-up implementation [37].

**Telerehabilitation**

The exercise-based cardiac rehabilitation (CR) in hospital or in rehabilitation centers is the supervised intervention with the best scientific evidence: mortality reduction, symptom relief, smoking cessation, and improved exercise capacity, risk factor modification and overall psychosocial wellbeing [38]. Based on the obvious evidence-based benefits, CR is recom-

---

**Table 3. Most promising application of remote patient monitoring**

<table>
<thead>
<tr>
<th>Most promising application of remote patient monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>• prevention and lifestyle interventions</td>
</tr>
<tr>
<td>• Chronic disease management</td>
</tr>
<tr>
<td>— hypertension</td>
</tr>
<tr>
<td>— diabetes</td>
</tr>
<tr>
<td>— heart failure</td>
</tr>
<tr>
<td>• arrhythmia detection</td>
</tr>
<tr>
<td>• telerehabilitation</td>
</tr>
</tbody>
</table>
mended by the American Heart Association (AHH), the American College of Cardiology (ACC), and the European Society of Cardiology (ESC) guidelines for patients with CAD [39, 40]. Telerehabilitation may be a support - or in case of lack of adequate cardiac rehabilitation programs — a substitute for this as home-based programs in particular in areas where cardiac rehabilitation programs are not available for patients within a reasonable distance. This is of particular interest in areas with low density population. In their most recent systematic review and metaanalysis of telehealth interventions versus center based CR comes to the conclusion, that telehealth intervention delivered cardiac rehabilitation does not have significant inferior outcomes compared to center-based supervised program in low to moderate risk CAD patients [41]. A recent cost-effectiveness analysis shows the addition of cardiac telerehabilitation to conventional centre-based CR to be more effective and efficient than center-based CR alone. These results are useful for policy makers charged with deciding how limited health care resources should best be allocated in the era of exploding need. In Australia, a smartphone-based home care model improved post-myocardial infarction CR uptake, adherence and completion and may turn out to be another promising adjunct to center-based rehabilitation [42]. Telehealth intervention offers an alternative deliver model of CR in particular for individuals less able to access center-based cardiac rehabilitation. Overall, the choices should reflect preferences, anticipation, risk profile, funding, and accessibility to health care.

Conclusions

e-Health and telemedicine are rapidly evolving and will become an important component of today's medical care there is an important gap between technically driven progress and application oriented research. Therefore, an important challenge for those involved in these new technologies will be to keep the main focus on patient individual needs and not to be overwhelmed by the enormous speed of progress in technology and informatics and to continue to carefully evaluate the evidence behind the practice.

Conflict of interest

The author declares that there is no conflict of interest

REFERENCES

5. doi. 10.1136/bmj.f030.
23. Wilkoff BL, Auricchio A, Brugada J, et al. HRS/EHRA Expert Consensus on the Monitoring of Cardiovascular Implantable Electronic Devices (CIEDs): description of techniques, indications, personnel, frequency and ethical considerations: developed in partnership with the Heart Rhythm Society (HRS) and the European Heart Rhythm Association (EHRA); and in collaboration
with the American College of Cardiology (ACC), the American Heart Association (AHA), the European Society of Cardiology (ESC), the Heart Failure Association of ESC (HFA), and the Heart Failure Society of America (HFSA). Endorsed by the Heart Rhythm Society, the European Heart Rhythm Association (a registered branch of the ESC), the American College of Cardiology, the American Heart Association. *Eurace*. 2008;10;707-725.


