e-Health innovation: time for engagement with the cardiology community

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e-Health is a broad term addressing the use of information and communication technologies in the support of health and health-related fields including healthcare provision, health surveillance, and education.1 e-Health can be divided into four areas:

(1) telemedicine and telecare (including disease management services, remote patient monitoring, teleconsultation, homecare);
(2) clinical information systems (electronic health records and decision support);
(3) integrated regional and national information networks and associated e-referrals; and
(4) cardiology registries and other non-clinical systems used for education, public health, and healthcare management.

Related terms also include m-health (‘mobile health’) building on the concept of mobile devices delivering health information such as drug and treatment options, screening patients, monitoring vital signs, providing direct care and patient education, and p-health (‘personalized health’) used to describe wearable micro- and nano-technologies with sensors, actuators, and ‘smart’ fibres to help facilitate personalized health and social care decision making and delivery.2 In 2010, COCIR, the European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry, established a dictionary of telemedicine terms to reduce the uncertainty surrounding the overlapping terms and concepts.3

E-health can provide innovative solutions addressing problems in ageing societies with increasing numbers of citizens living with chronic conditions, limited healthcare funding, and personnel. It can support the strong political drive to move care closer to patients’ homes and away from specialist centres. Technological innovation has brought e-health services that enable co-operation, information sharing, and decision support based on good practices and emerging evidence-based guidelines. However, social and technological issues hinder healthcare systems from reaping the benefits of wide adoption. Too often e-health services are technology-driven and health professionals have been resistant to their deployment and mainstream adoption, considering them ‘solutions seeking a problem’. Concern is raised about the risk of medicine becoming depersonalized, rather than e-health being considered as an aid to improve daily working practices, the allocation of resources, and ultimately to optimize patient outcome.

Telemedicine and telecare

Cardiology has always been at the forefront of what is now termed ‘e-health’ technology: in 1906, Einthoven4 investigated electrocardiogram (ECG) transmission over telephone lines; radio transmissions were used to link physicians to patients on ships for medical emergencies; and even as early as 1924 remote telecare was described as a possibility.5 Following decades of bold experimental research that set the foundations of biomedical engineering, in 1974 Jerome R. Cox, an engineer, AMIA fellow and Paul Hugenholtz, past European Society of Cardiology (ESC) president (1984–1988), established the annual Computers in Cardiology conference (now Computing in Cardiology—CinC). For 40+ years CinC alternates in Europe and in the USA6 serving as a forum for scientists and professionals in medicine, physics, engineering, and computer science to discuss their current research in topics pertaining to computing in clinical cardiology and cardiovascular physiology including e-health.7

Trans-telephonic monitoring of pacemakers was introduced in the 1970s,8 and of implantable cardioverter defibrillators in the early 1990s. At about the same time, ECG diagnosis of evolving myocardial infarction in the ambulance was piloted in the Netherlands.9 Food and Drug Administration approval and CE mark were first awarded for digital telemonitoring of cardiac implantable electronic devices (CIEDs) in 2002. All major vendors of such technology now support this capability, and early standards for remote monitoring have been set by professional bodies.10 In many countries, the legal framework and reimbursement policies

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are currently being established, and allow remote device monitoring to partly replace the hassle and costs of regular in-person visits to the hospital, while tapping the potential of early response to alarms for better patient outcomes.

Remote monitoring of chronic conditions, such as heart failure, has been subject to increasing attention. Meta-analysis of a number of small-scale studies of stand-alone systems suggested considerable clinical benefit when compared with the usual care provided at that time, but few data were available on the costs of such an approach, the nature of the interventions triggered by remote monitoring, or the re-education required to support healthcare professionals, patients, and their informal care givers in taking up their new roles. More recent and larger randomized trials, such as TIM-HF in Germany and Tele-HF in the USA, suggest that the specific type of technology used is crucial, as are the characteristics of the patients, to ensure that the technology used matches the need of the patient group. There may be little to be gained by continually monitoring patients with well-treated stable disease, but continuous monitoring and specialized interventions may be required when the disease is at an advanced stage. Targeted intermittent or ‘on-demand’ interventions to higher risk patients to support better care, education, self-monitoring, and compliance are likely to be more effective and a better use of resources than a ‘one-size-fits-all’ approach.

Remote monitoring of implanted devices, such as implantable cardioverter defibrillators or cardiac resynchronization devices, has been technically feasible for a considerable time.

Remotely evaluating alarms generated by the patient or the device can lead to immediate actions that may improve outcome. Such an evaluation could potentially replace some of the clinic or inpatient visits, thus saving costs for the hospital and reducing inconvenience for patients. Clinical decision support tools that process telemonitoring reports, clinical data from hospital electronic health records, and subjective personal health data in the context of the latest guidelines could contribute to a quicker and possibly more accurate clinical assessment.

Recent studies suggest that integration of signals from several monitored variables can facilitate earlier detection of arrhythmias or technical problems with devices, and better identification of patients at increased risk of deterioration. Trials of devices implanted solely for remote monitoring purposes (such as the recent COMPASS-HF and CHAMPION studies) also suggest that there is a subgroup of patients that might benefit from remote monitoring, although much remains to be worked out. Guidelines on the functionality and use of e-health services, including standards and terminology, need to be developed for different patient groups. Adoption of these new care practice guidelines could transform healthcare.

In the area of coronary artery disease, innovations in cardiac angiography and cardiac imaging in general allow real-time consultation of specialists and in some cases even therapeutic interventions. At the same time, research programmes like the Virtual Physiological Human and increased computing power have opened new ways in personalized ‘in-silico’ modelling of the heart and its response to interventions, and effective use of remote consultation to solicit the opinion of expert cardiologists.

Clinical information systems

Clinical information systems [i.e. Electronic Health Record (EHR) systems including decision support] have been gradually introduced in daily clinical care, initially following a parallel trajectory to that of telemedicine and telecare. A major obstacle to the adoption of Clinical Decision Support (CDS) has been the lack of interoperability that led to disconnected EHR systems. Nowadays, clinical information systems entering a new era as CDS is increasingly used in the daily practice of medicine. In particular, cardiologists rely on CDS in the programming and telemonitoring of CIEDs, functionalities integrated to patients’ electronic health records, in many large hospitals. In the future, as personal health records and health plans gain in popularity, activity and lifestyle data will no doubt also contribute to CDS. Moreover, due to financial incentives and possibly a change in culture, the adoption rate of EHR systems is steadily growing. However, with clinicians unsure what to expect from an EHR system, discussions on the functionality, standards, and certification criteria of EHR systems have come to the forefront.

Notably, in the USA the American College of Cardiology has provided guidance to cardiologists on what to expect and how to select an EHR system that is fit for purpose in their private practice. From a standards perspective, the ISO/HL7 EHR system functional model shown in Figure 1 specifies the general functionality that should be supported by an EHR system. Such functionality relates to direct care, supportive functions including financial accounting, and information infrastructure such as security and terminologies. Based on this general framework, organizations such as the European Institute for Health Records (www.EuroREC.org) in Europe and the Certification Commission for Healthcare Information Technology (CCHIT) in the USA have developed specialized profiles and comprehensive criteria to facilitate certification.

The domain of cardiology is unique in the multitude of data that a clinical information system needs to cover: numerous functional, biochemical, and electrical parameters including medical imaging are relevant when following a patient’s health status and progress. The 2011 Cardiovascular Medicine Certification Criteria by CCHIT shown in Figure 2 refer to data retention, availability, search and associations, key data elements (tests, reports, imaging, implant, surgical procedures, stress test, ECGs, vital signs, etc.), history and risk factors, user interface, and remote access considerations. The criteria include access to patient data across points of care, referring to documentation and trends in vital signs recorded outside the clinic in, for example, patient diaries. Although telemonitoring reports (e.g. alarms) are not specifically mentioned in the criteria, it is quite likely that they will be included in the future along with ‘feeds’ from personal health systems.

A highly functional and ‘connected’ health world would help us realize the full potential of evidence-based decision support, but this does require a dependable infrastructure that bridges the chasm between engineers and clinicians, and provides organizational support within an effective legal and financial framework. The eHealth Governance Initiative carries this vision forward, approaching relevant issues at the technical, organizational, and political level, with the key aims of mitigating risks and increasing
trust in, and acceptability of, technological advances for all concerned.

### Integrated regional and national information networks and associated e-referrals

For years there have been health information technology-driven initiatives on terminologies, standards, and interoperability over local, regional, national networks, but only lately has e-health been more widely accepted with best practice slowly emerging. The epSOS project ([www.epsos.eu](http://www.epsos.eu)) is a large-scale pilot supported by the European Commission and member states to establish cross-border e-prescription services and electronic patient summaries in 20+ European countries. epSOS moved forward and harmonized terminologies for e-prescription cross-border only to confirm the lingering problem of semantic interoperability that limits the meaningful exchange of EHR data among health organizations and professionals. The Semantic Healthnet network of excellence is a partnership among 40 major stakeholders in healthcare across Europe, supported by an extensive network of...
experts that aspires to meet interoperability challenges and enable the meaningful exchange of clinical information among EHR systems with a virtual organization that will establish and sustain semantic interoperability in Europe (see Figure 3). If semantic interoperability is achieved, clinical information systems will be able to identify important missing information, to raise alarms, to suggest appropriate investigations, diagnoses, and treatments, and to track patients along care pathways, while supporting clinical research and public health. ‘The doctor or nurse of the future is likely to depend on the assistance of an EHR for making decisions that ensure optimal clinical care’.

Cardiology registries and other non-clinical systems used for education, public health, healthcare management

Over the years the ESC has invested in innovation in education and learning by delivering rich content from its meetings online, by delivering a variety of specialty courses on webinars, and last but not least by delivering clinical guidelines to the personal digital assistants of specialists. Moreover, the cardiology community and the ESC in particular are championing the development of online patient registries such as the Heart Failure Long-Term Registry. Furthermore, recognizing the importance of systematic registration and harmonization of clinical data dictionaries for clinical care registries and audit, the ESC established the Cardiology Audit and Registration Data Standards (CARDS) project in 2003, and carried out in collaboration with the European Commission a pilot programme in an effort to stimulate the adoption of dictionaries by the member states. Today, patient registries are once again a focus area recognized by the European Commission, with the joint action on patient registries funded by DG SANCO.

Time for engagement

The European Commission’s drive for ‘Active Healthy Aging’ among our ageing populations has brought e-health to the tipping point, where closer engagement with the cardiology community is essential. It is time to establish where e-health works, where it does not, and where additional work is needed. Over the next years, the most important problem for cardiovascular care will remain the shortage of trained nurses and cardiologists, and that cannot be solved simply by e-health. The health workforce in collaboration with well-educated and trained medical and paramedical personnel should cover the increasing needs of the ageing populations especially in the industrialized countries.

At the e-health ministerial conference in Budapest in May 2011, a presidential declaration emphasized that e-health could support...
health systems to respond to the challenges of demographic ageing, the shortage of healthcare professionals, and the increase in chronic disease, by enhancing provision of timely and appropriate healthcare.29 The declaration recognized the need for investment in e-health but encouraged health professionals, and professional organizations such as the ESC, to actively support the implementation of e-health technology in clinical practice. The need for increased policy co-ordination, more research, and a wider evidence base on quantitative targets, including large-scale clinical trials was acknowledged, as was the development and validation of new delivery models transforming the process of care.

The European Commission has undertaken to support member states in deploying e-health solutions for chronic disease management and in setting quantitative targets such as reduction in hospitalization for heart failure, reduction in healthcare resources by patients with diabetes, and improvement in quality and length of life. It will encourage the development of clinical guidelines that support e-health, providing funding for large-scale pilots and comparative effectiveness research. There are real and perceived risks that e-health comes at the detriment of physiological and social aspects of medicine, and over time could result in excessive reliance of cardiologists on technology, and lower quality of healthcare, with increased medical errors. These risks should be mitigated by investing in research, training, and e-skills. Technology must support, and not destroy, person-centred care.

Cardiologists across Europe, working with the ESC and its national affiliates, are key to e-health innovation. We need to be involved, and to collaborate with engineers and other key stakeholders at each stage of the process: the technology design and integration, the assessment of the value of e-health innovation (in terms of the impact on patients, the healthcare system, and the costs), the education and support of healthcare professionals and patients, the development of guidelines, and the standardization of systems and models.

As a professional group, the ESC is often at the forefront of technological advances, and closer engagement with e-health innovation is urgently required. A work programme has been established, but integration within all of the activities of the ESC, and its affiliated groups, would help improve clinical engagement with e-health, helping to direct research and implementation efforts at a local, national, and international level.

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References
17. Whellan DJ, Ousdigan KT, Al-Khatib SM, Sarkar S, Porter CB, Pavi BB, O’Connor CM; PARTNERS Study Investigators. Combined heart failure device diagnostics identify patients at higher risk of subsequent heart failure hospitaliza-