1 Introducing eHealth

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eHealth, the use of technology to improve health, well-being and healthcare is increasing rapidly, see Figure 1.1 for an example. More and more innovative technologies have been introduced in healthcare and consumer practice, and are being studied by researchers. In this chapter, you will see that eHealth can have many advantages, like cost-effectiveness, process optimization and an increased reach and impact. It can improve the quality of care, for example, by significantly improving health and well-being, by enabling healthcare professionals to adhere more to guidelines and by resulting in higher satisfaction of patients. However, despite these advantages, eHealth has not yet reached its full potential. Many eHealth technologies are not used as much or in the way as was intended, the intended goals on efficiency and effectiveness are not achieved or problems with financing the technology are encountered. From this it becomes clear that there is room for improvement in the development, implementation and evaluation of eHealth.

In this chapter, we introduce eHealth and describe its emergence, the visions on eHealth in improving health and well-being and making healthcare more efficient and effective. We describe in what ways eHealth has been used in practice and what the added value of eHealth can be, showing observed benefits and barriers. Furthermore, the chapter introduces a participatory development approach, a holistic approach to guide the development, implementation and evaluation of eHealth technologies and interventions. The chapter ends with an outline of the book. After completing this chapter, you will be able to:

- explain the relationship between technology, psychology and health, and connect them to this book's vision of eHealth.
- state several areas of application of eHealth and provide accompanying examples.

Figure 1.1 An example of how technology can be used to support our health and well-being

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- name several benefits and barriers of eHealth in development, implementation, evaluation and use in practice.
- explain what a holistic vision of eHealth entails and why it is required to overcome the barriers and achieve the benefits.
- name and explain the importance of the five pillars of holistic eHealth development.

Why eHealth?

The essence of healthcare is to provide the best care possible that meets the needs of patients and their caregivers. However, due to declines in birth rates and longer life expectancies, the number and proportion of older people in our developed society is growing. An ageing population implies an increase in the chances of age-related illnesses like coronary heart disease, diabetes, and/or lung diseases. These *chronic diseases* cannot be cured, but they can be self-managed to maintain an acceptable quality of life. Older people may have more than one of these conditions (called 'multi-morbidity'), which makes the demand for successful care even more complex. It is important to support these older people so that they can manage their own chronic disease(s) as best as possible.

At the same time, fewer working-age adults are available to support the increasing number of older people. Preserving high standards of patient-centred care will, therefore, be a challenge in the near future. Not surprisingly, all this leads to the concern that a healthcare system with an acceptable quality of care will become too expensive to sustain. In most countries, the delivery of the necessary care with fewer resources is considered to be a major political challenge. The healthcare system is in great need of innovation.

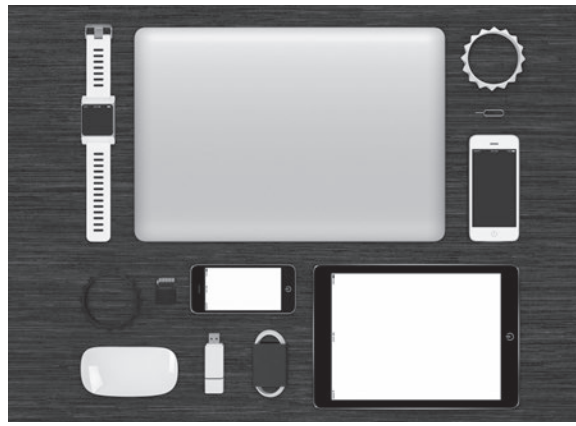

Figure 1.2 Examples of technologies that can be used to improve health and well-being

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A particular trend in the world today is that patients and their 'informal caregivers' (such as family members) are more in the lead of their own healthcare. This is in contrast to the traditional model, in which a professional caregiver is in the lead and makes most of the decisions. This enhanced status and empowerment of patients and their informal caregivers increases the involvement of patients in the management and treatment of their health and well-being. A cooperative model of healthcare encourages and expects active involvement of all the parties involved – the patient, caregivers and healthcare professionals alike. This concept of 'participatory health' is also applicable to prevention, physical fitness, nutrition, mental health, end-of-life care, homecare and other fields related to an individual's health. This increasing importance of participatory health requires innovative ways of support.

Researchers and policy makers from all over the world are looking for these innovative solutions, and many have been thought of and tried out in practice. Serious future options include: de-hospitalization, organizing healthcare into regional networks, adequate homecare, and the concentration of highly specialized, complex care in one location. Since a large proportion of the population has access to and uses the Internet in their daily lives (via, for example, a PC, tablet, *wearables* and/or smartphone; see Figure 1.2), the role of technology is emphasized in such solutions, both within and outside of healthcare.

Ways of looking at using technology to support health

With the introduction of the Internet, *eHealth* became popular as an instrument for communication between patients and caregivers and for providing health-related information instead of paper-based information and telephone-guided communications. In 2001, an influential paper by Eysenbach called 'What is eHealth' started a

discussion about it which resulted in many views and definitions (Oh, Rizo, Enkin, & Jadad, 2005). These definitions all described eHealth as a way to communicate via technology but failed to address the reasons for doing this and the implications of using technology in healthcare.

Beyond the emerge of several definitions, different taxonomies appeared which represent different ways of looking at eHealth (van Gemert-Pijnen, Peters, & Ossebaard, 2013):

- Categorizing eHealth technologies according to their place in the healthcare continuum: describing services to support care delivery (diagnostics, therapy, treatment, etc.), to manage care (personal health records, portals, etc) or to promote prevention and education as part of public health self-management programmes.
- Categorizing eHealth technologies according to the characteristics of the technology: describing the capacities of devices and systems to support human-computer interactions, to monitor and coach people and to develop tailored and personalized health interventions. For example, robotics, domotics, *wearable devices*, *virtual reality*, personal health records or web-based applications.
- Categorizing eHealth technologies according to their influence on the healthcare system: describing the infrastructure for healthcare, emphasizing the possibilities of technologies to innovate or disrupt healthcare. Examples include social media, *wearables* and collaborative decision-making support systems to develop an infrastructure that breaks through traditional care with patient-centric care models.

What this shows is that the field of eHealth is very broad and, more importantly, that eHealth has an impact on many aspects related to healthcare and well-being. We have seen that the Internet created new opportunities for exchange of information and for interactions among patients and between patients and caregivers. These opportunities empowered patients because they have become more active participants in management of their health and well-being, and this has impacted the healthcare infrastructure, for example, by providing care that is affordable and accessible everywhere and anytime, and by sharing knowledge to everyone who has access to the Internet. As Eysenbach already stated in 2001, eHealth is more than just introducing technology in healthcare (Eysenbach, 2001):

> eHealth is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology.

Box 1.1 eHealth terminology

Within this book, several terms that are used in the field of eHealth interventions are used. Many of them can be used interchangeably, but they all have their specific meaning, as is explained below.

eHealth: The use of technology to support health, well-being and healthcare.
eHealth technology: The actual technological instrument via which health, well-being and healthcare are supported, often information or communication technology.
eHealth intervention: An eHealth technology specifically focused on intervening in an existing context by changing behaviour and/or cognitions.
Health informatics: The interdisciplinary study of the design, development, adoption and application of IT-based innovations in healthcare services delivery, management and planning. Also called 'medical informatics'.
Behaviour change interventions: Behavioural change interventions are interventions designed to affect the actions that individuals take with regard to their health.

The Eysenbach statement is beyond defining eHealth merely as a tool or a device to change information or to facilitate communication. eHealth disrupts the healthcare infrastructure and delivery, and it implies that people should have the capacities and capabilities to use technology to support self-care and to create novel ways of healthcare delivery; affordable, accessible and feasible for all. eHealth is a process to transform healthcare, taking into account the whole human being in the context of living and working. This context is continuously changing due to demographics, changes in roles and role-players in healthcare and the growing capacities of technology to generate and communicate data.

Throughout this book, the term eHealth will be used in multiple forms. Box 1.1 provides a brief overview of the terminology used.

eHealth: technology and psychology

eHealth: technology

eHealth and technology are inseparable, since the first is not possible without the second one. Therefore, well-functioning technology is a necessary precondition for a good *eHealth intervention*, and a good design that appeals to *users* is beneficial as well. Because of this, it seems logical to pay attention to the role of technology within eHealth, but unfortunately this is often overlooked.

Developments in the domain of eHealth are dependent on the development of technologies. The first eHealth technologies were websites with plain text, mainly because the technology back then did not offer many more options. However, soon eHealth became increasingly interactive, making it possible to communicate with its users. Since then, new ways for technology to monitor and communicate with us are always emerging. Technology also offers users the possibility to communicate with each other, for example, enabling patients to contact their physicians or other patients, and the possibilities in this area are still evolving. At this point, technology is increasingly becoming part of us and our daily lives. This humanizing technology is very relevant for eHealth: the 24/7 monitoring of our physical state and behaviour offers many options for coaching health and well-being. However, this raises several ethical concerns about how far we can go in this, how reliable feedback of technology should be, and who the owner of all of the collected data is. Another important issue for eHealth is the balance between following the newest trends and innovations in technology, which might have unknown effects, or using well-researched but less state-of-the-art technologies.

An important point with respect to technology is, regardless of the type of technology, the fit with the user and context. If the users feel like the technology does not match their needs and preferences, or cannot be embedded in their routines, it will not be used. A technology should fit the way people live and work, their socio-economic backgrounds and the way they make decisions about their health and well-being (Beerlage-De Jong, 2016; Wentzel, 2015). This match is important for concepts like *user engagement*, *adherence*, trust and *involvement*, that will be fully explained later in the book (see Chapter 13). To put it bluntly: the better the fit with user and context, the more likely it is that a technology will be used and is effective. In order to achieve this, a good *development process* is essential. For instance, system design models for technology design are not always suitable for eHealth development, since a focus on matters like the user perspective, the context and financing is also needed. To conclude: technology is essential for eHealth, and developers should always make sure that there is a good fit between the technology, the user and the context (van Gemert-Pijnen et al., 2013).

eHealth: psychology

eHealth aims to improve health and well-being, using technologies. Often, a change in people's cognitions and behaviours is required to achieve this, but changing behaviour via interventions has proven to be very difficult. Merely using a well-functioning and nice-looking technology doesn't suffice: theories and approaches from psychology should be used to create technologies that can enable behaviour change.

Research has shown that eHealth interventions that use psychological behaviour change theories are more effective in changing behaviour than those that do not (Webb, Joseph, Yardley, & Michie, 2010). Consequently, approaches such as *behaviour change techniques* (Michie et al., 2013) or persuasive features (Oinas-Kukkonen & Harjumaa, 2009) should be used in eHealth interventions. Behaviour change techniques are derived from abstract psychological theories and can be used in interventions (see Chapter 2). *Persuasive technology* aims to persuade users in a positive way to make better choices for their health and well-being. It does this by using

the characteristics and possibilities of technology, such as cues for communication (text, speech, video, graphics), anonymity, or its possibility to access situations in which human persuaders are not allowed (see Chapter 11). The use of these kinds of approaches in a design increases the chances of effective behaviour change.

Furthermore, eHealth technologies have to be used by people, so they should fit their perspective. Merely using theory doesn't account for this important aspect. When theory-based interventions are created behind a desk, without talking to actual people, chances are that they don't appeal to or fit the user, since the developers can be mirroring themselves and are thus implicitly designing for themselves. Designing for your target group requires knowledge of how people think and behave. Psychological theories and methods can be used to get a grasp of this, since psychology pays a lot of attention to analyzing and explaining human behaviour via research methods such as interviews, observations and questionnaires.

Integrating psychology and technology

Psychology and technology are both important ingredients for successful eHealth interventions and should be intertwined. Figure 1.3 visualizes this

Figure 1.3 Technology can influence our cognitions, and our cognitions influence the way we view and use technology

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interrelationship. However, in many cases, the content of an intervention is developed by social scientists, and the technology is created separately, by engineers or technology designers. Understandably, both groups speak different languages, often causing a lack of collaboration or project management. For example, a team of psychologists might have a certain design in mind to deliver the content for an intervention. They communicate this to designers who have to 'translate' the delivered content into a technology that fulfils the need of content experts. Unfortunately, this often proves to be challenging because of misunderstandings or differences in preferences and experiences. Consequently, content and technology are often developed independently from each other, which often causes the perspectives of the *user* and *stakeholder* to be forgotten along the way. To prevent this, collaboration is key. Content and technology developers not only should closely communicate with each other but should also be in frequent touch with users and other stakeholders to ensure that an eHealth intervention is an integrated whole that fits all stakeholders' needs as closely as possible.

Benefits of eHealth

The first part of this chapter has given a high-level idea of why eHealth is necessary. In this section, we will discuss in more detail why eHealth can be of added value. eHealth can have different advantages in different contexts and for different people. Therefore, an exhaustive list of all the possible eHealth benefits is impossible to compile. Also, not all benefits will always be true for every eHealth technology. Again, this is because the technology's added value will be different depending on the context and the people. The benefits below are provided to give an idea of some of eHealth's advantages for healthcare and people in general. They refer to the access to care that eHealth can enhance, the empowerment of patients and healthy people via eHealth, its possibilities for innovating healthcare and the way we look at health and well-being, and its potential for improving quality of care.

Access to care

Via eHealth, healthcare can become available independent of time and place because people can access it whenever and wherever they need it. An example is someone who has a busy working schedule and trouble making appointments with his or her diabetes nurse. eHealth provides a way for him or her to have some of her consultations occur online, through secured email contact. Furthermore, someone living in a remote area might, instead of driving for an hour, use Skype to contact his or her general practitioner.

eHealth can also create a lower threshold to access healthcare, which entails that more people have a possibility to access healthcare (WHO, 2016). With easier access, healthcare becomes more equally distributed among people, allowing for an improvement in healthcare equity. For example, online support groups enable social networking and emotional support of isolated individuals. However, a precondition for the actualization of this benefit is online access and a satisfactory

amount of (computer) skills. eHealth can also remove thresholds to healthcare like stigmatization. An example of this is the provision of anonymous online consultations or anonymous peer-to-peer online communication. An HIV patient who may be uncomfortable finding help in person might be more willing to talk with peers online.

Empowerment

Technology may empower people by giving them the opportunity to take more control of their own healthcare. Technology can enable people to choose when and where they want to access healthcare. In this way, they are more in control of their own health and care process. Furthermore, people can be empowered when they are educated about their health and more aware of their own health data. For example, technology can give people access to their own health data, which increases people's knowledge about their own health, through personal health records or via self-generated data via monitoring technologies such as wearables.

Patient-centredness is another important advantage. Technology can enable people to choose when and where they want to access healthcare. Also, the information people can collect can make it easier for them to make their own informed health decisions, or to have more equal discussions with their doctors, since patients are becoming experts on their own health.

Finally, care professionals can be empowered as well. Technology can provide tailored support on medical decision making, among other things, via data-driven diagnosis support and *artificial intelligence*. Watson (see Chapter 3) is a question-answering technology that uses natural language and has the computational power to facilitate informed decision making using big data. Quick diagnoses and precise and personalized medicine is made possible by such systems, and this leads to more transparent healthcare decisions because it is known on what grounds decisions have been made.

Innovation

New technologies and new applications of technologies open up a whole range of possibilities for healthcare (see Chapter 4). The mere use of technology will not automatically result in long-lasting and positive change, but it can provide the groundwork for sustainable change in healthcare by supporting important movements within the domain such as *patient-centred care* and integrated care. A straightforward example of this is the opportunities that technology can create for easy communication, audio and video, between different healthcare professionals.

The possibilities that eHealth offers can be seen as a catalyst for innovation in healthcare. Technology has the ability to change the way healthcare is delivered by stimulating all involved stakeholders to critically think about how they deliver or receive care. This opens up new ways of thinking, which can in turn stimulate innovation. For example, think of a wearable that monitors the movement of COPD patients 24/7, this information can be extremely valuable to doctors since it might be used to predict exacerbations.

Quality of care

The quality of healthcare can be improved via highly efficient, innovative systems and by effective interventions that lower costs and increase safety by reducing human errors. eHealth technologies can incorporate medical guidelines and quality standards for healthcare, for example, via an app that supports nurses in prescribing antibiotics to patients at their bedsides. This makes following guidelines or standards independent of individual care providers' skills and knowledge and an integral part of the regular process. Information systems can even monitor real-time compliance with guidelines to support safety at work.

Effectiveness can also be improved by using the possibilities of technology to improve traditional interventions and treatments. For instance, think of an intervention for stimulating activity and monitoring stress levels in depressive patients, where wearables can track a person's activities during the entire day. The collected data can be used to provide tailored advice, something that current traditional interventions and therapists cannot do.

Efficiency is an important benefit as well, since eHealth can require fewer resources to achieve the same quality of care and effects on health and well-being. Teledermatology – the use of audio and video communication in the assessment and treatment of skin conditions and tumours – can decrease the number of doctor visits, saving costs and time.

eHealth: in practice

eHealth is increasingly being used in practice. In this section, we will provide several examples to give you an idea of what eHealth can look like and to see how the benefits may be achieved. Within the field, there is not one categorization that is perfect and always applicable, mainly because of the continuously evolving possibilities of technology. We use a categorization below that is based on the level of involvement of specific stakeholders: *self-care and prevention*, *supportive care* and *societal health*.

Self-care and prevention

In this domain, the patient or health consumer is in the lead: technology can be used to foster *self-management* in an easy and convenient way (see Figure 1.4 for an example). Examples are using a website or app to find health-related information, talking to peers with similar health issues in a discussion forum or following a self-help course to quit smoking or lose weight. Sometimes a healthcare professional can be involved, for example, when he or she answers a question in an e-consultation or gives feedback within a self-help course, but this is not necessary.

In its simplest form, *self-care and prevention technologies* can be employed to provide information on health and well-being. There are many websites dedicated to offering credible and understandable health information. A straightforward example is a website where you can find a lot of information on the influence of alcohol on your brain. However, most eHealth technologies provide

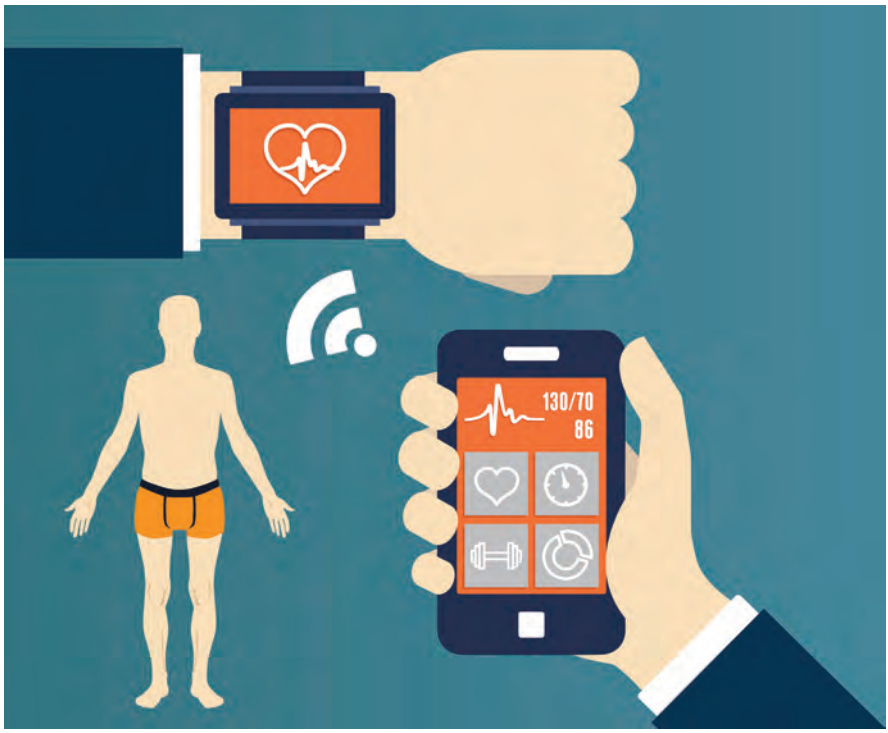

Figure 1.4 An example of how technology, in this case a smartwatch that monitors physical states and an app, can be used to self-manage health

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not only information but also an opportunity to interact with the system. These decision aids are a way to allow the user to interact with the information. For example, they can be simple question-and-answer systems that help health consumers or patients make a decision on what to do with a certain health complaint or disease. Decision aids can help you to decide whether you need to visit a doctor, or assist you in choosing the type of therapy that best suits you, for example, whether or not to have surgery for carpal tunnel syndrome. Ideally, these systems are based on medical protocols. In addition, technology can support interaction with others in multiple ways. There are technologies that support interaction between people with similar health issues, like discussion forums. Technology can also support interaction with care providers, for example, through moderated discussion forums or e-consultation. In the latter case, these systems should enable safe and secure communication and account for privacy rules.

Another form of self-care and prevention can be found in technologies that support *(self)-monitoring* of health-related information. For example, the quantified self-movement is enabled by industrial companies providing wearables like

smartwatches that track, trace and trigger behaviours and moods to support healthier lifestyles or to reduce medical issues. Activity and sleep trackers have become more popular and mainstream in recent years and have inspired many individuals to monitor many aspects of their daily life through technology. These devices can help you gain insight into how healthy you actually are. Some examples are the Misfit, the Apple watch, and the Fitbit. Also, these wearable technologies are more and more used in medical settings, using wearable sensors (e.g. EEG and ECG) generating real-time data about health-related variables (heart rate, blood pressure, glucose levels, etc.).

The last example of self-care and prevention in eHealth technologies are online (self-help) treatments. These exist for many lifestyle areas, such as physical activity, diet and smoking, but also for mental health. Many online treatments can be followed without support from a therapist, such as for depressive complaints, but there are also online treatments available with therapist support, open to anyone, even without a prescription from a healthcare provider. Also, these online interventions are being increasingly used in combination with face-to-face therapies, called *blended care* (Wentzel, van der Vaart, Bohlmeijer, & van Gemert-Pijnen, 2016). Ideally, online treatments are based on evidence-based protocols and grounded in theories like *Cognitive-Behavioural Therapy* or *Acceptance and Commitment Therapy*. They often use a fixed structure of lessons. For example, every lesson starts with an explanation of the purpose of the lesson, followed by assignments, exercises and useful information provided by experts.

Supportive care

This domain is characterized by more involvement of the healthcare professionals and, ideally, healthcare professionals and patients work together to manage or improve the health of the patient or client. In this domain, the care process is often more complex than in self-care and prevention, as caregivers are involved for a longer period of time, or multiple caregivers are involved, as is visualized in Figure 1.5. The care of patients with a chronic disease such as diabetes is an example of this. eHealth can play an important role in *supportive care*. For instance, it can improve the information exchange across professionals or between professionals and their patients, as well as provide online self-management support, and monitor the performance of disease management programmes.

An example of the role of eHealth in supportive care is *telemedicine*. In 1995, teledermatology, a form of telemedicine, became one of the first examples of eHealth among healthcare professionals. In teledermatology, telecommunication is used to exchange long-distance medical information, for example, by means of video conferencing. This can enable one dermatologist to ask for another colleague's opinion about skin conditions based on actual images. As compared to just a text message or phone call, images can help dermatologists give more reliable advice. This case shows eHealth as a valuable tool to support care decision making.

Electronic *personal health records* (PHRs) are another example of promising eHealth technology for supportive care and chronic disease management. A PHR is

Figure 1.5 An example of the role that technology can play in the healthcare process. Patient data is automatically collected and sent to a General Practitioner. It is also stored in a database that saves this information and makes it available to other healthcare professionals

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an electronic application through which individuals can access, manage and share their health information and that of others for whom they are authorized, in a private, secure and confidential environment. Recently, many PHRs have added functionalities in order to support disease management. Besides sharing clinical and personal data (e.g. disease history, test results, treatment plans and appointments) between patients and care providers, these systems often include functions to support self-management like working on health-related goals while being supported by a care provider and/or the system, and patient-care provider communication, which allows patients to keep in touch with their care provider or make new appointments.

Societal health

In this domain, patients and healthcare professionals are both involved, but the lead is at a higher, societal level. *Societal health* focuses on broad health-related issues that might affect individuals. However, societal health issues can never be solved by the behaviour of just one individual (like self-care) or by a small group of people (like supportive care). Societal health issues demand that governments play a vital role in creating policies and regulations. In turn, healthcare inspectorates must implement and maintain these policies and regulations. Examples of such broad societal health issues are the prevention, spread and control of diseases and infections as well as access to healthcare for everyone. As you can imagine, due

to its large reach, interactivity and ability to provide easy access to information, eHealth is often seen as a way to improve the health and well-being of individuals on a large scale. Since eHealth can help to change people's attitudes and behaviour, it can be used to address societal health issues or gain information about them.

First, eHealth can influence the attitude or awareness of individuals about societal health issues. An example of this is the CDC (the U.S. Centers for Disease Control and Prevention) 'Solve the Outbreak' game. In this game, you become a disease detective trying to fight an outbreak before it can spread any further. The goal of this app is for the general public to learn about diseases, their outbreaks and the complexity of managing those outbreaks.

Second, it can be used to support behaviour that is compliant with guidelines that are required to manage broad health-related issues. Technology can help healthcare professionals follow policies or guidelines in a care environment, for example, in managing their use of antibiotics in order to decrease the spread of resistant bacteria. This is a societal health issue, where, for example, the government plays an important role in creating the policies on how to deal with this challenge. Technology can assist in translating such policies into action.

Finally, technology can support communication between health professionals about societal health issues. An example of this is the risk communication, decision making and education of healthcare professionals about zoonoses. Zoonoses are infectious diseases of animals that can be naturally transmitted to humans, like Lyme disease and MRSA. A technology such as a serious game can be used to support this.

eHealth barriers

Multiple (potential) benefits of eHealth were described earlier. However, in practice, eHealth technologies are often not as successful as expected: not all potential benefits are reached. There are multiple barriers that cause this gap between the current situation and the potential. Some of the most important ones are described below. Attention will be paid to barriers with regard to the implementation of an eHealth technology in practice, (potential) ethical barriers and barriers on evidence and research on eHealth technologies.

Implementation barriers

Implementation of eHealth refers not only to its introduction in a specific context but also to its dissemination and long-term use. A successful eHealth intervention should be embedded in practice and used as was intended, but multiple factors can negatively influence its uptake in practice (Greenhalgh et al., 2017, also see Chapter 12).

First of all, a lack of incentives to use technology can result in a resistance to use it. For eHealth to be used it should be financially feasible, but often there are no obvious financial benefits, and it is not clear enough who pays for what. For example, e-Consultation failed because the reimbursement for using it in a general practitioners practice was lower than face-to-face visits. Incentives can also be related

to perceived benefits for people's health and well-being. Self-management portals to support patients with chronic care, although proven effective, are often not used because patients feel they are not benefitting enough. This could happen because of the distinct 'feeling' caused by the lack of human support in self-management portals. When people's needs are not acknowledged and thought through during the development process, the eHealth technology can lack commitment and support because people do not perceive enough financial or personal benefits.

Also, a lack of eSkills can hinder the uptake of eHealth technologies. Merely using the Internet is not a guarantee people have the capacities and skills to manage their own health with technology. Digital health literacy is often assumed, although many people are not educated or trained to use technologies or to understand self-management data visualized via graphs or tables. This lack of familiarity with technology can have a negative impact on the reach of health technologies, since highly educated people often benefit more than people with a lower education level.

Furthermore, there often is a lack of motivation to start or continue using an eHealth technology among users and other stakeholders. eHealth technologies touch the lives and work of many people. When the interests of these people are not acknowledged and thought through, the new eHealth technology can lack support. Think of nurses who have been told to start using an app that they haven't agreed to use in the first place and which may not fit into their individual work routines. Once people have accepted a technology, motivation can still be an issue: many people stop using a technology prematurely or do not use all of the available opportunities. This issue is called non-adherence and indicates that eHealth interventions are not always motivating enough to use in the long term, which hampers effectiveness.

Lack of confidence in technology is another barrier. People might fear that they will be substituted by technology, for example, in the case of robots. Also, a well-known problem in practice is the fear that a technology might decrease the quality of treatment: a psychologist might fear that the use of technology in treatment will negatively impact the therapeutic relationship with his or her client. Creating confidence and showing how technology can have added value for people should be part of the introduction and implementation strategies to innovate healthcare.

Technologies are developed using different software and hardware elements, with the frequent result of systems not being interoperable. This makes it difficult or even impossible to communicate information from one system to another. In other words, interoperability is low. For example, wearables to monitor behaviour are sometimes not compatible with other apps on a smartphone. Or data generated by systems that track activities, mood and food intake are not interoperable with platforms to translate the data into personalized coaching strategies.

Finally, unclear regulations can hinder successful use of eHealth technologies in practice. Often there is lack of clarity about legal issues. Think about who is ultimately responsible for an online diagnostic system. What happens if a monitoring and coaching system does not refer a patient to a hospital when it actually should have done so? Who is responsible when a wrong suggestion is made? More attention should be paid to legislation issues on a national level and within health institutions.

It is clear that issues that might hinder implementation need to be identified in advance so that they can be accounted for before the technology is fully developed: a good development process increases the chances of good implementation (see Chapter 12). In a good development process, attention is paid to the values of the users and other stakeholders, the characteristics and nature of the context in which the technology will be used and the design of the technology itself (see Chapter 7).

Ethical barriers

The barrier of regulations touches upon the topic of ethics and its importance for eHealth. Of course, ethics is not a new phenomenon with respect to health information, but the use of technology in healthcare raises many new ethical issues that have to be accounted for. The process of storing and sharing health data becomes beyond peoples' ability to directly control. This impacts multiple factors that should be addressed to increase the chances of eHealth's success in the long term.

Privacy and security are obstacles people perceive when using technologies to share health or medical information. Who is the owner of the information? And how do we know who has access to the information? Companies might sell personal health information or can use this information to make decisions about peoples' health conditions. For example, companies provide technologies to monitor physical activity, sleeping and eating behaviours with monitoring devices such as smartwatches. These devices collect data that can be analyzed using algorithms to personalize health and provide tailored feedback to people on how to reach their goals. These data provide much insight into people's health and might be misused by, for example, health insurance companies to increase their premiums for people with an unhealthy lifestyle.

The lack of transparency is not a new phenomenon per se compared to traditional care, but the difference is that the 'clinical eye' of a caregiver is missing. For example, people receive tailored feedback on their behaviour but often do not have any idea what decision rules ground the personalized feedback. Technology provided by industrial companies requires clear policy and rules about the transparency of data.

The quality of information is another ethical aspect. To what extent can we trust the information that is provided by the Internet? Think of Wikipedia pages that can provide unreliable and incorrect information about symptoms or treatments, or a system that provides wrong feedback about the amount and intensity of physical activity for an obese person. Credibility of information can be guaranteed by companies that check the information using certain standards or by providing medical approvals by appropriate regulatory agencies, such as the U.S. Food and Drug Administration or the U.K. Medicines Control Agency.

People use technology for self-regulation, like devices for self-testing health. An issue is how this impacts the autonomy and trustworthiness of healthcare. For example, self-regulation is possible by using sensors for monitoring and automated coaching. However, these monitoring devices are not 'tested' following medical standards, using clinical trials. People adopt self-regulation devices rapidly, and

infiltration with medical practices is ongoing. This can put medical professionals under pressure: how should we cope with information from data that is not based on medical standards? How should we respect patients' self-judgements? How should we use self-test information in clinical consultations?

It becomes clear that these ethical issues are pivotal to eHealth's success to ensure that negative consequences are avoided. We should study these ethical issues in depth. Stakeholders such as software developers, caregivers, patients and equipment suppliers should participate in ethical discussions to ensure that we are proactive in the ongoing path of innovations.

Evidence barriers

A critique on eHealth interventions is the limited large-scale -evidence of the *cost-effectiveness* of eHealth interventions and the little information on long-term effects on health and healthcare. More good, long-term evidence is needed: the more we know about what works, why and for whom, the more we can optimize eHealth.

The main barrier regarding evidence can be found in the study designs that are used to evaluate many eHealth interventions, as they don't always address the full picture. In general, the effects of web-based interventions are measured with the golden standards for clinical interventions (*Randomized Controlled Trials; RCTs*). These experimental or sometimes quasi-experimental studies use cut-off measurements at fixed points in time to determine if an eHealth intervention was successful in improving predetermined outcomes. An example would be whether an intervention was successful in reducing depressive complaints or increasing physical activity. However, these conventional pre-post comparisons do not help us understand what elements of the intervention contributed to outcomes. Factors such as costs, usage of the technology and other outcome variables should be measured continuously since they are also really important processes. The need for this type of evidence requires other evaluation methods.

Another barrier to evidence is related to this main issue: we do not have enough knowledge on the process of *adherence*, which refers to the question of whether the technology is used as was intended by the developers. We know that many people are not adherent: they stop using the technology prematurely, or do not use all of its different possibilities, which might have a negative influence on the intervention's impact. More knowledge is required on what impact this non-adherence has on effectiveness and what factors can predict or even influence adherence to eHealth interventions.

Furthermore, as was mentioned before, mere information on effectiveness on specific outcome measures doesn't suffice for eHealth. Since it is always used within specific contexts and can influence the way healthcare is delivered, information on eHealth's impact on these contexts is required as well. Consequently, we need information on the reach of eHealth to, for example, find out which share of the target group actually accessed an intervention. Matters such as *adoption* – answering questions about when and how people started using the technology – and the implementation process should be studied as well to get a holistic view of the impact of the eHealth technology.

Another issue that has to be addressed to ensure that the quality of eHealth evidence increases is related to the way evaluation studies are reported. Many studies have a rather myopic view on technology and evaluation, meaning that they do not provide enough information about matters that need to be reported to ensure replicability of studies and interventions. For example, in most cases it is unclear which software functionalities and development methods have been used to create the technology. Studies do not report why and how a certain technology was used, developed and implemented: evaluation is merely outcome driven and little to no attention is paid to the quality of the evaluated technology. As a consequence, it is impossible to identify what specific features of technology could have contributed to the effects of the eHealth interventions, and replication is hardly possible. To overcome this problem, a CONSORT checklist was developed to guide how 'eHealth and mHealth trials should be reported, in particular related to reporting sufficient details of the intervention to allow replication and theory-building' (Boutron, Altman, Moher, Schulz, & Ravaud, 2017).

Finally, eHealth technology is not fixed: it can be *tailored* to different user profiles, and can be constantly updated and adapted by developers or users. In controlled, experimental studies with only a few measurements, these changes in technology are often not considered as subject for research, though they are important. A flexible intervention requires a flexible evaluation approach, which can be provided by *agile* science. In agile science, development and evaluation occur in parallel, iteratively, until the eHealth technology has been optimized to fit the complex context in which behaviour occurs. Advanced methods such as time series and log data can be used to provide ongoing information about the use of technology and its impact on the context and people. This kind of information is necessary to take eHealth evaluation to the next level and overcome evidence barriers.

It is important to overcome these evidence barriers to increase the added value of eHealth in practice. We need not only more evidence on effectiveness but also more insight into the working elements of eHealth interventions. This requires both applied and fundamental research. *Applied research* focuses on matters such as good design, implementation, use of in practice and effectiveness of an intervention, all within specific contexts. *Fundamental research* aims to make generic claims about constructs such as adherence, behaviour change theories, persuasive elements or *tailoring*. It is needed to empirically ground eHealth in theories on, for example, behaviour change and well-being. The results of experiments and empirical studies can be used to validate abstract theory-driven behaviour change models or to develop new models to predict reach, usage and adherence. These models are useful for applied research in which they can be used to, for example, optimize interventions.

A holistic approach towards eHealth development and evaluation

As we have seen, eHealth has many proven and potential benefits, but there are still many barriers that need to be overcome. One way to overcome these barriers is to employ a *holistic approach* towards eHealth development and evaluation.

In 2011, a review on the potential and limitations of existing eHealth frameworks was conducted to find their value in overcoming these barriers (van Gemert-Pijnen et al., 2011). A main outcome was that these kinds of issues are expected to be avoided by applying a *participatory development* process that creates a good fit between technological, human and contextual factors. However, most existing frameworks were found to have a rather conceptual approach instead of practical guidelines, and lacked the stakeholder-driven approach that is required in eHealth development (van Gemert-Pijnen et al., 2011).

Based on this review and prior research, a holistic approach was proposed. Holism in general refers to the notion that individual elements in a complex system are determined by the relations they bear to the other elements. This means that all aspects of a larger whole are interrelated, and separate analysis of its parts should be avoided (James, 1984). For eHealth development, this means that constructs as technology, people and context are all interrelated and interdependent, and are all part of one whole instead of separate elements (Van Gemert-Pijnen et al., 2011).

Such a holistic approach is required since eHealth is much more than a thing or tool. It entails creating an infrastructure for supporting health, organizing care, disseminating knowledge and communication via technology. eHealth developers should be aware of the impact that technology can have on people (patients, citizens, healthcare professionals, policy makers) and their sociocultural context (healthcare organization, homes). Approaches such as *participatory development*, *human-centred design* (see Chapter 10), *business modelling* (see Chapter 9) and *persuasive design* (see Chapter 12) can be combined into a framework that supports the developers in this. The *CeHRes Roadmap* does just that: it combines these approaches and thus provides a framework to develop a technology that fits the human and contextual perspective (see Chapter 7). The Roadmap is underpinned by five pillars of eHealth development, which are based on existing frameworks, insights from practice and empirical research (van Gemert-Pijnen et al., 2013; van Gemert-Pijnen et al., 2011). These pillars are described in the following section.

eHealth development is a participatory development process

Many eHealth technologies are known to have acceptance problems, which can be attributed to insufficiently meeting the needs of users (Eysenbach, 2008). To prevent dominance of experts when making decisions about development, and to account for the user and context, stakeholder participation is essential (van de Belt, Engelen, Berben, & Schoonhoven, 2010). In this so-called *participatory development*, stakeholders are involved during the entire development and evaluation process. These *stakeholders* include the users, but other stakeholders are essential for a proper *development*, *implementation* and *evaluation* as well. Merely involving users might cause a dominance of the user perspective (Bødker, Kensing, & Simonsen, 2009) and can lead to overlooking the needs of other stakeholders who will use, implement or be in any way involved with the technology (see Chapter 8).

Development 'with' instead of 'for' stakeholders entails their active involvement in activities related to the development, implementation and evaluation of eHealth. Their roles can range from informant to actual co-creator (Scaife, Rogers, Aldrich, & Davies, 1997; Yip et al., 2013). Stakeholders help to create the technology by means of being involved in activities like identifying their needs for the technology, improving the technology based on their input or identifying critical issues for implementation (Carr, Howells, Chang, Hirji, & English, 2009). However, participatory development does not always have to be about creating new technologies. Existing technologies can be redesigned and reused in different contexts, and it is important that stakeholders are involved in that process as well (see Chapter 10).

eHealth development creates new ecosystems for improving health and healthcare

The use of eHealth technology is never isolated but is influenced by and influences the context in which it is used. In the case of eHealth, the context differs, for example, ranging from a hospital and its organization to a user's home and personal life. For eHealth technologies to reach their potential, a good fit with this context is required. Consequently, eHealth development creates novel structures and processes for healthcare delivery; an ecosystem for healthcare emerges. eHealth reshapes healthcare, since it intervenes with traditional healthcare characteristics. Some of these changing characteristics are a change in place-dependant delivery, a new division of labour, new regulations for the use of technology financing, and a shift from hospital to home-based care (see Chapter 4).

eHealth development is intertwined with implementation

Too often, *implementation* is seen as post-design activity that is executed only after the design of a technology or other kind of product is finished. However, current visions of eHealth development state that implementation plays an important role right from the start. As we have discussed, many issues can arise during implementation in practice (Broens et al., 2007; May et al., 2007). If these potential implementation issues are identified during the earliest stages of the development process, they can be addressed before the actual implementation starts. Decreasing, making a plan to account for, or eliminating these implementation issues before implementation reduces the chances of their having a negative effect on the implementation (see Chapter 12).

Also, involving the perspective of the users, other stakeholders and the context from the beginning increases the chances of a good fit with the technology, which in turn increases the chances of a smooth implementation process. The better the fit and interrelationship, the higher the chances of successful implementation in practice. This means that actively involving stakeholders in the development process and making sure their needs are incorporated in the technology contributes to implementation as well.

eHealth development is coupled with persuasive design

eHealth can be used for multiple purposes: to support self-management behaviour, to educate, to share personal information, to influence attitudes or to facilitate communication between people. But regardless of its main goal, all eHealth technologies have in common that they are always used by people. These people expect technology to support them in doing the right thing, show understanding, giving them information that is relevant for themselves, rewarding their behaviour and being easy and intuitive to use. People often have to be supported in changing their behaviour and attitudes, and technology has the potential to do this (see Chapter 12).

Persuasive technology is technology aimed at influencing behaviour and attitudes. This refers to behaviour and attitudes that contribute to an improved health and well-being but also to behaviour and attitudes related to (the use of) the technology. Persuasive technology can have a positive influence on using the technology in the intended way and in the long term; it has the potential to improve adherence (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012). If a technology is used in the right way, it is more likely to reach its health-related goals. In other words: persuasive technology supports people in improving their health and well-being by using the system in the intended way.

eHealth development requires continuous evaluation cycles

eHealth development is not a linear process with consecutive steps. It is an iterative, flexible and dynamic process during which constant changes can be made to development activities and their results. Consequently, evaluation should also be seen as cyclic, longitudinal research and development activities interwoven with all development phases, without a fixed end. This means that evaluation doesn't take place only at the end of the development process; just like implementation, it is not a post-design activity. *Formative evaluation* starts at the beginning of the development and continues during every development activity. Each product of a development phase can and should be critically checked, analyzed, evaluated and adapted based on the results of this formative evaluation. It can take on different forms, for example, verifying outcomes of a phase with users, checking the relation with the outcomes of previous phases, or gathering stakeholders' opinions on a specific idea. In every case, its main goal should be checking that the outcomes of activities still match the context, stakeholders and outcomes of previous phases. Formative evaluation provides concrete tools to further improve the process and technology in order to reach an optimal fit between technology, stakeholders and context (see Chapter 7).

Furthermore, much eHealth research focuses on evaluating the effectiveness of an implemented technology to make claims about whether the goals have been reached. Less attention is paid to outcomes related to the healthcare context and the interaction between the user and the technology, which can be seen as equally important. Just like eHealth development, evaluation should be holistic: it has to focus on the technology, users and the context. Also, evaluation does not have a fixed end point, since its results can be used to further improve or change a

technology. Once implemented, a technology is not fixed but can be redesigned. These improvements or changes should be evaluated as well, and again, more changes can be made based on the outcomes of the new evaluation cycle. Evaluation doesn't have to be the end point of the development process, since a technology is never really finished. This requires an iterative, flexible and dynamic view on evaluation (see Chapter 14).

Roadmap to the book

The concept of holism is intertwined throughout the pillars: they emphasize the importance of a good fit between technology, people and their context. *Holism* is an essential principle of this book since all chapters are connected by these interrelated concepts. The first part of the book (Chapters 2 through 6) will elaborate on the background of eHealth by focusing on the interrelationship between technology, psychology and healthcare and by introducing eHealth's use in prevention and somatic and mental healthcare. The second part of this book (Chapters 7 through 14) pay attention to holistic eHealth development, design, implementation and evaluation. The CeHRes Roadmap provides the backbone for this part. More information on this book's main goals and structure can be found in the Preface.

Summary

This first chapter introduced the domain of eHealth and described the relationship between technology, psychology and healthcare. It provided an overview of current visions of eHealth. The chapter made clear that changes in healthcare, society, technology and the behavioural sciences are all related to eHealth, directly or indirectly. This results in many advantages of eHealth, but in practice, barriers are still experienced. In order to overcome these barriers and achieve the benefits, a holistic, multidisciplinary approach is advocated. Such a development approach will likely result in an eHealth technology that fits the people and their environments. The take-home messages for this chapter are:

- eHealth has many actual and potential advantages for health, well-being and healthcare and can be divided into self-care and prevention; supportive care and societal health.
- In practice, many barriers of eHealth are experienced with regard to implementation in practice, ethics and evidence.
- A holistic vision of eHealth is advocated: the technology, people and their contexts are all intertwined.
- A holistic development, design, implementation and evaluation process can create eHealth technologies that overcome the barriers and achieve the benefits.
- The CeHRes Roadmap can support holistic eHealth development and is based on approaches such as participatory development, human-centred design, business modelling and persuasive design.

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