1 Introducing eHealth

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Introduction

eHealth, the use of technology to improve health, well-being, and healthcare is increasing rapidly. The rapid development of technologies such as VR, mobile apps, and wearables has instigated their application to healthcare. In this chapter, you will read that eHealth can have many advantages, like cost-effectiveness, process optimization, and an increased reach and impact. It has the potential to improve the quality of care, for example, by enabling healthcare professionals to better adhere to guidelines or by increasing patient satisfaction. The COVID-19 pandemic accelerated the use of some technologies, like video-consultation and telemonitoring, and ensured a change in prior regulations regarding the use of technology in healthcare. However, eHealth has not reached its full potential yet. Many eHealth technologies are not used as much or as intended, the goals on efficiency and effectiveness have not been achieved, and problems with financing the technology have been 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, describe how eHealth can be used to improve health and well-being, and its possibilities to make healthcare more efficient and effective. We describe how eHealth is used in practice and what the added value of eHealth can be, including observed benefits and barriers. 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 eHealth;
- State several areas of application for eHealth and provide accompanying examples;
- Name several benefits and barriers of eHealth related to its 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 of eHealth;
- Name and explain the importance of interdisciplinary development, implementation, and evaluation of eHealth.

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

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Why eHealth?

The essence of healthcare is to provide the best care possible that meets the needs of patients and their (social) environments. However, our healthcare system is under pressure. For example, due to declines in birth rates and longer life expectancies, the number and proportion of older people in our 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. Many of these diseases are chronic diseases, which means the focus of care is more on managing the disease rather than on curing it. Older people may have more than one of these conditions simultaneously (called 'multi-morbidity'), which makes the demand for high-quality care even more complex. Another factor contributing to the rise of chronic conditions that require long-term care is lifestyle: Many people have unhealthy habits such as smoking, a sedentary lifestyle, or a diet with too much fat and sugar. This is related to problems such as joint pain, lung cancer, or diabetes mellitus type 2. Furthermore, an increase of mental illnesses such as depression and anxiety have been observed in many countries. These factors result in a high demand for good healthcare. Besides that, it is of importance to maintain the feasibility of this level of quality care over time. To this end, efforts are made to limit the demand for care, e.g., by focusing more on prevention of lifestyle-related disease, decreasing relapse in addiction, or to increasing patient satisfaction. This is highly relevant since, at the same time, fewer working-age adults and limited financial resources are available to support the increasing number of people with a need for care. Preserving high standards of patient-centred care with fewer resources is a challenge. This shows that the healthcare system is in great need of innovation.

A particular trend in the world today is that patients and their 'informal caregivers' (such as family members) are more in the lead in taking care of their own health. This is an extension of the traditional model, in which a professional caregiver is in the lead and makes most of the decisions. To allow patients and their informal caregivers to take on a more actively involved role in the management and treatment of their health and well-being, requires a shift in the way the healthcare system is shaped. Researchers and policy makers from all over the world are looking for innovative solutions that support patients and their informal caregivers, and many possible solutions have

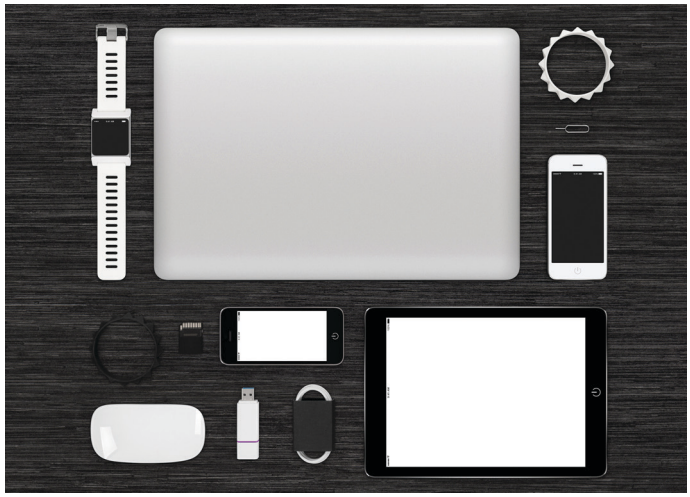

Figure 1.2 Examples of technologies that can be used to improve health and well-being.

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been thought of and tried out in practice. Serious options include de-hospitalization, organizing healthcare into regional networks, adequate homecare, and the concentration of highly specialized, complex care in one location. An integral part of many of these options is the use of technology. 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). Consequently, the role of technology is emphasized in such solutions, both within and outside 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. There have been active discussions about views and definitions on eHealth (Oh, Rizo, Enkin, & Jadad, 2005). The definition provided in an influential paper by Eysenbach called 'What is eHealth' in 2001 is still much-used:

> *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.*
>
> (Eysenbach, 2001)

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 thus influences and is influenced by the context in which it is used. This context is

Box 1.1 eHealth terminology.

Within this book several terms that are used in the field of eHealth technologies are referred to. Many of them can be applied 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 system via which health, well-being, and healthcare are supported, often referring to information or communication technology;
- *eHealth intervention*: An eHealth intervention that is delivered through or supported by technology in an existing context by changing behaviour and/or cognitions;
- *Behaviour change interventions*: Behaviour change interventions are interventions designed to intentionally affect the actions that individuals take with regard to their health.

continuously changing due to demographics, changes in roles and role-players in healthcare, and the growing capacities of technology to generate and communicate data, showing the importance of constantly verifying whether eHealth is still optimally aligned with a specific context.

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

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. Within the field, there is no one perfect categorization that is always applicable, which has to with the continuously evolving possibilities of technology. In this book, we use a categorization that is based on the way different types of stakeholders are involved: *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. eHealth can be used to foster *self-management* in an easy and convenient way (see Figure 1.3 for a visualization). 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 unidirectionally provide information on health and well-being. There are many websites dedicated to offering credible and understandable health information, e.g., on the influence of alcohol on your brain. However, most eHealth technologies not only send information, but also offer an opportunity to interact with the system. Decision aids are one way of allowing the user to interact with information. In their simplest form, it can be question-and-answer systems that help health consumers or patients to decide 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, and as of recently, they can be supported by artificial

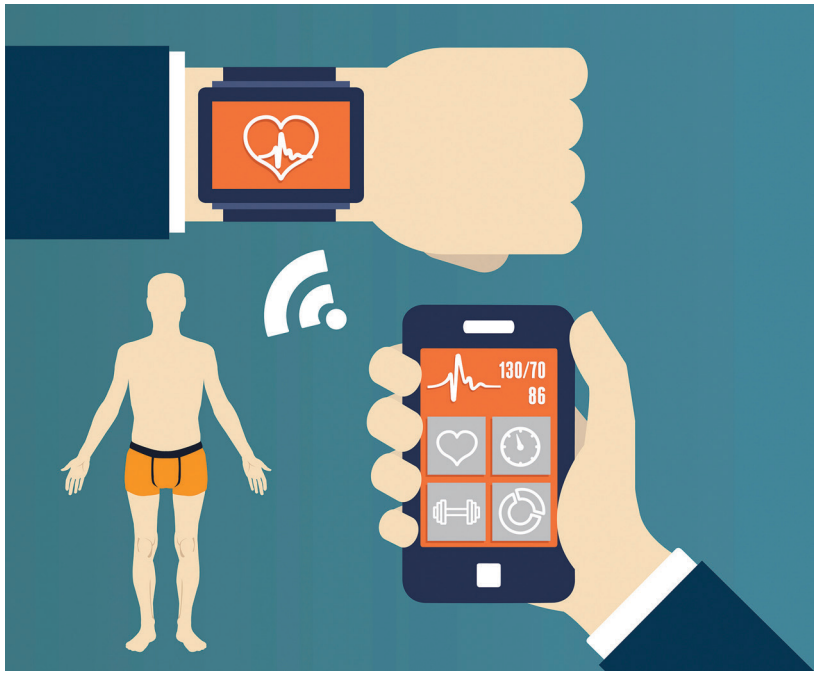

Figure 1.3 An example of how technology, in this case a smartwatch that monitors physical states and an app, can be used to self-manage health.

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intelligence. In addition, technologies such as discussion fora can stimulate interaction with others (e.g., with similar health issues) in multiple ways.

Another form of self-care and prevention can be found in technologies that support (*self)-monitoring* via the use of health-related information. Think of wearables like smartwatches that monitor behaviours such as physical activity or sleep. These data can be used to offer individual coaching, e.g., by motivating someone to move more in case of a lower step count, or to go to bed earlier in case of a lack of sleep. Sensors can also be used to collect real-time data about other health-related variables, such as heart rate, blood pressure, or glucose levels. In any case, it is important to interpret these data with care, since they might not always be as valid or reliable as a system might make them out to be. For example, an increased heart rate may be a sign of unhealthy stress, but it might also be an indication of healthy physical exercise.

A last example of self-care and prevention in eHealth technologies are online (self-help) interventions. These exist for many lifestyle areas, such as physical activity, dieting, and smoking, but also for mental health issues, such as (mild) depressive complaints, stress, or anxiety. Ideally, such online interventions are based on evidence-based protocols and are grounded in theories like *Cognitive-Behavioural Therapy*. They often use a fixed structure of lessons. For example, every lesson may start with an explanation of the purpose of the lesson, followed by assignments, exercises, and useful information provided by experts. Many of these interventions can be followed individually, at one's own pace and time, without support from a therapist. There are also online treatments available with therapist- or automated-support, open to anyone, even without

a prescription from a healthcare professional. These types of interventions can prevent a further increase of (mental) health complaints by providing low-threshold treatment early on.

Supportive Care

This category of eHealth is characterized by more involvement of healthcare professionals. Ideally, if resources allow it, healthcare professionals and patients work together to manage or improve the health of the patient. 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 1.4. The care of patients with a chronic disease such as diabetes is an example of this. For instance, eHealth 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.

One of the oldest examples of the role of eHealth in supportive care is *telemedicine*. In 1995, tele-dermatology – a form of telemedicine – became one of the first examples of eHealth among healthcare professionals. In tele-dermatology, telecommunication is used to exchange long-distance medical information, for example, by means of videoconferencing. This can enable a dermatologist to remotely diagnose skin lesions or allow 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.

Electronic *personal health records* (PHRs) are another example of eHealth technology for supportive care and chronic disease management. A PHR is 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 healthcare professionals, these systems often include functions to support self-management.

Figure 1.4 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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Examples are working on health-related goals while being supported by a healthcare professional and/or the system, and facilitating communication between patient and healthcare professional, which allows patients to interact with their healthcare professional 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, of which the COVID-19 pandemic is an example. 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 and health authorities 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 – which is especially relevant for low-income countries. 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 and thus improve the health of a society as a whole.

First, eHealth can influence the attitude or awareness of individuals about societal health issues. An example of this is the CDC (the U.S. Center 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. Second, eHealth 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 adhere to 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. Third, eHealth can be used to manage the behaviour of individuals during outbreaks of infectious diseases. An example are the mobile contact tracing apps that were introduced during the COVID-19 pandemic in multiple countries. Via Bluetooth, users received a notification when they had been within a specified distance (e.g., 1.5 meters) of an infected person. Finally, technology can support communication between health professionals about societal health issues. An example of this is the risk communication and education of healthcare professionals regarding zoonoses. Zoonoses are infectious diseases that are transmissible between animals and humans, like Lyme disease, MRSA, and COVID-19. Dealing with an outbreak of a zoonotic infection requires acute intensive cooperation between disciplines that do not normally do so. A technology such as a serious game can be used to support this. By simulating an outbreak, awareness of the importance of collaboration is raised among healthcare professionals. If such a game can be deployed in blended form, it can also contribute to low-threshold strengthening of the professional network.

Benefits of eHealth

In the first part of this chapter, we have given a general idea of the potential of eHealth and why it sometimes even seems necessary to use it. 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 hold true for every eHealth technology. Again, this is because the technology's added value will vary 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. People can access it whenever and wherever they need it. An example is someone who has a busy working schedule and has trouble making appointments with his or her diabetes nurse, they can now contact the nurse whenever it suits them through a digital messaging service. Or think of the COVID-19 pandemic: Many people were still able to contact a caregiver via e.g., videoconferencing, despite lockdowns or quarantine. Furthermore, someone living in a remote area might use videoconferencing to contact his or her general practitioner instead of driving for an hour or so.

eHealth can also create a lower threshold to access healthcare, which means that more people have a possibility to access effective healthcare (WHO, 2016). With easier access, healthcare becomes more equally distributed among people, allowing for an improvement in healthcare equity. For example, think about the use of mobile apps for mental healthcare that can freely be used in low-income countries. These types of scalable interventions have the potential to reach thousands or even millions of people in need of care. Other examples are the use of online support groups to enable social networking of isolated individuals, or the use of an anonymous intervention for people with stigmatized illnesses, e.g., sexually transmitted diseases. A patient who may be uncomfortable finding help in person, due to taboos, might be more willing to talk with peers or care professionals online. However, there are preconditions for the actualization of this benefit, such as having access to the Internet and possessing satisfactory digital skills.

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 care. For example, digital mental health interventions can be used to receive treatment outside of sessions with a psychologist, in a patient's own time. Working independently on (parts of) treatment might allow patients to attribute more positive change to their own effort, as opposed to only their caregivers'. Furthermore, people can be empowered when they are educated about their health and become more aware of their own health data, e.g., data on test outcomes in a personal health record, or data on sleep or steps per day collected by a wearable.

Patient-centredness is a closely related advantage. The patient-specific health data that are collected and analyzed via technology, allows healthcare to more specifically account for the individual patients' health needs and goals. It also facilitates shared decision making, which is a collaborative process through which caregiver and patient together come to a decision about treatment.

Finally, healthcare professionals can be empowered as well. Technology can provide tailored support for medical decision making, for example via *artificial intelligence*. Think of an AI-system that provides doctors with predictions on if and when a patient can best be discharged from a hospital. Furthermore, caregivers can use mobile apps to look at diagnoses or protocols. Quick, valid diagnoses and precise and personalized medicine are made possible by such data-driven systems.

Innovation

New technologies and new applications of technologies open up a whole range of possibilities for improving or even drastically changing healthcare (see Chapter 4). The mere use of technology will not automatically result in long-lasting and positive change, but if it is implemented well,

it can provide the groundwork for sustainable change in healthcare. For example, eHealth can support important movements such as towards *patient-centred care* and shared decision making. A straightforward example of this is the opportunity that technology can create for easy communication between different healthcare professionals, e.g., consulting a specialist on a specific disease who lives in another country via videoconferencing. Another example is the use of mobile apps or Internet-based interventions in mental healthcare. These types of innovations can drastically change the role of a therapist, which might shift from being completely in charge regarding the content of treatment, to a more supportive role in which the patient works on large parts of treatment individually.

The possibilities that eHealth offers can be seen as a catalyst for innovation in healthcare. Technology can change the way healthcare is delivered, for example by opening up access to an array of data via the introduction of EMRs, or even by stimulating all involved stakeholders to critically think about how they deliver or receive care. Thus, on the one hand eHealth creates the technological opportunity for innovation, while on the other hand it also provides inspiration to see and discover new possibilities.

Quality of Care

The quality of healthcare can be improved via innovative systems and effective interventions that might result in lower costs and increased 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 preparing and administering antibiotics to patients at their bedsides. This makes following guidelines or standards independent of individual healthcare professionals' knowledge and an integral part of the regular process. Information systems can even monitor real-time compliance with guidelines, e.g., hand hygiene, 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 interactive virtual reality intervention in which patients with aggression-regulation problems can safely practice with remaining calm in different types of settings, together with their therapists. This provides new ways to practice with behaviour, as opposed to only talking about it in a treatment room. Another example is the use of an intervention for stimulating physical activity in patients with obesity, where wearables are used to track a person's activities throughout the day. The collected data can be used to provide tailored coaching – 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. For example, tele-dermatology – the use of video communication in the assessment and treatment of skin conditions – can decrease the number of doctor visits, saving costs by delivering high quality of care with fewer personnel. It can even contribute to preventing hospital admissions by catching e.g., skin tumours early on due to a lower threshold for receiving care.

eHealth Barriers

Up until now, we have mostly discussed the advantages of eHealth. However, in practice, eHealth technologies are often not as successful as expected. There are multiple barriers that cause this gap between the current situation and the potential benefits eHealth can bring – if it is used as intended. Furthermore, it is important to not just look at the possibilities of eHealth, but also critically reflect on barriers related to, for example, legislation or ethics. There are many barriers towards eHealth so this is not a comprehensive overview. For overview purposes, we divided them into implementation, ethical, and evidence barriers.

Uptake Barriers

Implementation of eHealth refers not only to the individual uptake in a certain context, but also to the integration in healthcare practices and maintenance for long-term use and upscaling a technology to the market. 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; Chapters 13 and 14).

First of all, a lack of incentive to use technology can result in a resistance to use it. For eHealth to be used it should be financially feasible. However, there often are no obvious financial benefits, and it is often not clear enough who pays for what. For example, videoconferencing (e-consultation) was often unsuccessful in reaching sustained use, because the reimbursement for using it in a general practitioners practice was lower than face-to-face visits. Innovative business models are needed to invest in technologies that provide care. For example, the shift from hospital care to homecare and the role of technology in supporting this requires different financing systems.

It is also not always clear if and how people benefit from eHealth: What is the added value? For example, 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 may for example be because of a perceived lack of human support. When people's needs are not acknowledged and thought through during the development process, eHealth technology can lack commitment because they do not perceive enough benefits for health or well-being.

Low eHealth literacy can hinder the uptake of eHealth technologies. Merely having digital skills or possessing a smartphone is not a guarantee people have the capacities and skills to manage their own health using technology. For example, people can have difficulty in understanding self-management data visualized via graphs or tables – implying the need for a suitable design that fits people's skills or might simply be a lack motivation to use it. These types of difficulties with using eHealth can further increase the digital divide, since highly educated people often benefit more than people with a lower education level.

Furthermore, there is often 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 (Kelders et al., 2013).

Lack of trust or confidence in eHealth is another barrier. Healthcare providers 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 think that the use of an eHealth intervention in treatment could negatively impact the therapeutic relationship with his or her client.

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, since they cannot 'talk' to each other. For example, wearables to monitor behaviour may not be compatible with other apps or personal health records. In particular, the shift from hospital care to homecare requires that standardized labels for treatment are used within systems, which is usually not the case.

Finally, certification of a technology, general data protection regulations (GDPRs), and medical device regulations impact the uptake of eHealth technologies in practice. The certification procedures that are necessary for the medical device regulations that currently often apply to

eHealth technologies are time-consuming and associated with high costs. In practice, there is often not enough expertise to comply with certifications and regulations. It is important to account for these types of regulations and responsibilities from the start, since they are often overlooked during development and implementation.

Ethical Barriers

A very important aspect to consider when using (new) eHealth technologies, are ethical points of attention. Of course, ethics is not a new phenomenon with respect to health information, but the introduction and integration of eHealth technology in healthcare raises many new ethical issues that must 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. Not all ethical barriers have a solution or a clear-cut answer yet. However, it is pivotal to carefully consider the ethical barriers that may arise.

Privacy and security are obstacles people perceive when using technologies to share health or medical information. Patients often do not have enough knowledge about what happens to their data. Who is the owner of the information? And how do we know who has access to the information? Commercial companies might sell personal health data. For example, companies provide technologies to monitor physical activity, sleeping, and eating behaviours with monitoring devices such as smartwatches. These data provide much insight into people's health and, if not protected well, might be misused by, for example, health insurance companies to increase their premiums for people with an unhealthy lifestyle.

A lack of transparency is not a new phenomenon, but the difference is that the 'clinical eye' of a caregiver can be overruled. For example, people receive tailored feedback on their behaviour, but often do not have any idea what decision rules ground the personalized feedback. This highlights the role of 'explainable AI': AI should not be a black box, but it has to be clear on what grounds decisions are made. In line with this: What happens when a 'wrong' decision is provided by an eHealth technology? Who is responsible?

The reliability and accuracy of information provided by an eHealth technology is another important point to consider. 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 a person with obesity and joint problems. This highlights the importance of reliable certification, the importance of involving the perspective of a healthcare professional, and educating the end-user so they are able to critically assess the reliability of provided information or suggestions.

While empowerment via eHealth is an important benefit, it might also have a negative impact on healthcare. People independently use commercial technologies such as wearables or self-testing to improve their health. An issue is how this impacts the autonomy and trustworthiness of healthcare. People adopt self-regulation devices rapidly, and 'infiltration' with medical practices is ongoing. This can create pressure for medical professionals: How should they cope with information from data that is not based on medical standards? How should patients' self-judgements be respected? And how should we use self-test information be used in clinical consultations?

Finally, eHealth always aims a change in cognitions or behaviours, and uses certain persuasive strategies to ensure that users are optimally supported in their desired behaviour change. However, there also is a 'dark side of persuasion'. How far can we go in changing behaviour? When are suggestions provided by an app too intrusive? How can we ensure that the user (or healthcare professional) remains in control, and that the technology does not have an undesired impact on behaviour? It is important to carefully consider how far we can and want to go with the use of each technology.

Evidence Barriers

An important critique on eHealth technologies is the limited large-scale evidence of their *cost-effectiveness*, and the relative scarcity of reliable information on long-term effects on health and healthcare. More such evidence is needed: The more we know about what works, why and for whom, the more we can optimize eHealth.

One of the first barriers is that since eHealth is a relatively new domain, there are not that many studies on its effectiveness compared to other interventions, such as certain types of drugs, treatment for cancer, or cognitive behavioural therapy. The paradox here is that before eHealth is implemented, we need evidence for its effectiveness, but it is difficult to study this effectiveness if eHealth is not implemented well. As the field further progresses and gains some age, more studies are conducted and we learn more about why eHealth does or does not work, but we still need to be careful when drawing conclusions about its effectiveness.

A related barrier can be found in the study designs that are used to evaluate many eHealth interventions, as they do not always address the full picture. In general, the effects of web-based interventions are measured with the gold standards for (clinical) interventions (*Randomized Controlled Trials; RCTs*). While this type of study design is suitable for testing the effectiveness of e.g., drugs or a new type of treatment for cancer or the effectiveness of a face-to-face CBT-intervention for anxiety, the model is not always suitable for determining if an eHealth intervention was successful in improving predetermined outcomes. eHealth interventions differ for everyone through, for example, personalization of the intervention and the fact it is sometimes difficult to control the intervention (like with drugs or a face-to-face encounter with a psychologist). An example would be whether an intervention was successful in reducing depressive complaints or increasing physical activity. Conventional pre-post comparisons do not help us understand what elements of the intervention were and were not used and contributed to outcomes. Factors such as costs, usage of the technology, and other outcome variables should be measured more continuously since they are also really important processes. Furthermore, mere information on effectiveness on specific outcome measures does not 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. The need for this type of evidence requires other evaluation methods that are more suitable for eHealth (also see Chapter 16).

Another barrier to evidence is related to how eHealth is used. We do not yet 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 has a negative influence on an eHealth 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.

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 design and 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).

A final barrier is the need to better combine fundamental and applied research, since we not only need 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 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*. 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.

eHealth: Technology and People

As can be seen in the previous sections, eHealth cannot exist without people such as patients and healthcare professionals and is also highly dependent on the possibilities of technology (van Gemert-Pijnen et al., 2011). In this final section, we dive into two important concepts for eHealth: Technology and psychology.

eHealth: Technology

eHealth and technology are inseparable, since the first is not possible without the second. Therefore, well-functioning technology is a necessary precondition for any good *eHealth intervention*, and a good design that appeals to *users* is beneficial as well. As a result, it seems logical to pay attention to the role of technology within eHealth, but, unfortunately, this aspect 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 technology did not offer many more options. However, eHealth soon became increasingly interactive, making it possible to communicate with its users. Since then, new ways for technology to monitor and coach its users are emerging – think of smartwatches that measure our heartrate variability and send a notification when it exceeds a certain threshold to support us in reducing stress. Technology also offers users the possibility to communicate with each other, for example by enabling patients to contact their physicians or other patients, and the possibilities in this area are still evolving, as became apparent during the COVID-19 pandemic. 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 supporting improvements in our health and well-being. However, this raises several ethical concerns about how far we can go in this: How reliable should feedback of technology be, and who is the owner of all of the collected data? 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 and perhaps less appealing technologies.

An important point regarding any technology is its fit with the user and the context in which it is used. 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, should be aligned with their skills and socio-economic backgrounds, and has to appeal to way they make decisions about their health and well-being (Beerlage-De Jong, 2016; Wentzel, 2015). 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. To achieve this, a *participatory and interdisciplinary development process* is essential. For instance, system design models for technology are not always

suitable for eHealth development, since a focus on matters like user perspective, context, and financing are 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

The goal of eHealth is to improve health and well-being via technologies. Often, a change in people's cognitions and related behaviours is required to achieve this, but changing behaviour has proven to be very difficult. Merely using a well-functioning and nice-looking technology does not suffice: Theories and approaches from psychology should be used to create content for technologies that can enable behaviour change.

Research has shown that eHealth interventions that use theories grounded in behavioural science are more effective in changing attitudes and behaviour than those that do not (Webb, Joseph, Yardley, & Michie, 2010; Carey et al., 2019)). Consequently, approaches such as *behaviour change techniques* (BCTs; Michie et al., 2013) and persuasive features (Oinas-Kukkonen & Harjumaa, 2009) should be integrated in eHealth interventions. BCTs are derived from psychological theories and can be used in interventions (see Chapter 2). For example, the BCT 'reward' can be integrated in an app by providing the user with a compliment after completing a task, e.g., reaching the intended number of steps per day. *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 12). 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 analysing and explaining human behaviour. Also, methods from human-centred design can be used to actively involve the users in the development process via research methods such as interviews, observations, and usability tests (see Chapter 11).

Integrating Psychology and Technology

Psychology and technology are both important ingredients for successful eHealth interventions and should be intertwined. Figure 1.5 visualizes this 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 these content experts. Unfortunately, this often proves to be challenging because of misunderstandings or differences in preferences and perspectives. As a result, content and technology are often developed independently from each other, which can lead to a neglect of perspectives of stakeholders along the way. To prevent this, multi- or interdisciplinary collaboration during development 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

Figure 1.5 Technology can influence our cognitions, and our cognitions influence the way we view and use technology.

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ensure that an eHealth intervention is an integrated whole that fits all stakeholders' needs as closely as possible.

eHealth – A Multidisciplinary Approach

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 ensure that enough attention is paid to the development, implementation, and evaluation of eHealth (van Gemert-Pijnen et al., 2011; van Gemert-Pijnen et al., 2013). Participatory development – in which relevant stakeholders are actively involved in creating the technology – is important to ensure that content and design fit their needs. Thorough implementation is essential to ensure that an eHealth technology is used in the long term and that it is financially sustainable. Evaluation is essential to assess the added value of a technology, but also to identify points of improvement. More attention to these processes is paid in Chapter 7. However, what is important to note before diving into this book, is the importance of a multidisciplinary approach. As we have seen, eHealth is not a unidimensional thing or tool: There is a close interrelationship between the design and content of the technology, its

end-users, other stakeholders, and the healthcare context in which it will be used. To fully account for all perspectives throughout the development, implementation, and evaluation processes of eHealth, methods, frameworks, and theories from different disciplines need to be used. The most important disciplines that are discussed in this book are psychology, engineering, health sciences, human-centred design, business modelling, and implementation science. It is important to note that in regard to eHealth, these disciplines are not separate entities, but are integrated and interrelated, resulting in a multi- or even interdisciplinary approach in which technology, people, and their context are related.

Roadmap to the Book

The interdisciplinary approach towards eHealth and its development, implementation, and evaluation are central to this book. The first part of the book (Chapters 2 through 6) elaborates on the interdisciplinary background of eHealth by diving into the constructs of human behaviour, the possibilities of technology, and the healthcare system. In this first part, attention is also paid to the current state of affairs regarding the role of eHealth in prevention, and somatic and mental healthcare. The second part of this book (Chapters 7 through 16) pays attention to the development, implementation, and evaluation of eHealth, using frameworks, models, and theories from disciplines such as health psychology, human-centred design, engineering, business modelling, and implementation science. The CeHRes Roadmap (Chapter 7) – a framework for holistic, interdisciplinary eHealth development, implementation, and evaluation, provides the backbone for this part.

Summary

This first chapter introduced the domain of eHealth and described the relationship between technology, psychology, and healthcare. It provided an overview of benefits and barriers related to eHealth and this was illustrated through multiple brief examples. It is important to note that while eHealth has many advantages, many barriers are still experienced in practice. To overcome these barriers and achieve the benefits, an interdisciplinary approach towards development, implementation, and evaluation is advocated. Such an approach will likely result in an eHealth technology that fits people and their environments. The take-home messages for this chapter are:

- eHealth is the use of technology to support health, well-being, and healthcare, and can be categorized into self-care and prevention, supportive care, and societal health;
- Potential benefits of eHealth are related to access to care, patient empowerment, innovation, or quality of care;
- In practice, many barriers to eHealth are experienced with regard to uptake in practice, ethics, and evidence;
- When looking at eHealth, it is essential to consider the perspective and characteristics of the technology, the involved people, and their healthcare context;
- An interdisciplinary development, implementation, and evaluation process can create eHealth technologies that overcome the barriers and achieve the benefits.

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