

Towards a Unified Understanding of eHealth and Related Terms – Proposal of a Consolidated Terminological Basis

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Abstract: The impact of digitization on healthcare gives rise to interdisciplinary concepts such as eHealth. However, achieving improvements in research and innovation requires a valid and unified understanding of the common terminology. Yet, a heterogeneous usage of different terms regarding eHealth can be observed. This leads to a deficient communication between researchers and practitioners, impeding the diffusion, i. e. extensive practical implementation of innovative health concepts. To address this problem, our aim is to consolidate and harmonize eHealth-related terminology. To this end, a literature analysis was conducted to identify established definitions and to formulate a terminological ontology for the related concepts. The current results show a consistent definition of the terms digitization, ICT, and telematics. In contrast, telemedicine, telehealth, eHealth, and mHealth were identified as conflictingly defined terms. Consequently, the proposed ontology serves as a first guidance to support an adequate use of the included terms. Further systematic research of terms is needed to verify the current concept of the ontology. Additionally, specifying the connection between the ontology and the elements of healthcare systems is required for a deeper understanding of the influence of digitization in healthcare.

1 INTRODUCTION

Telemedicine and eHealth are said to change the way healthcare is delivered. These concepts are seen as potential solutions to overcome communication breakdowns (loss of information), avoid multiple assessments, and improve quality of care as well as patient satisfaction (Kruse et al., 2013).

Approximately 20 % of physicians in Canada are currently using eHealth tools on a daily basis in routine care (Razmak and Bélanger, 2017). In 2013, 53 % of all Americans had looked up plausible medical conditions online before consulting their physicians (Fox and Duggan, 2013). Looking at the 91 % of all Americans who own a smartphone, up to 13 % of them use health apps. Smartphone owners use their phones in 31 % of the cases to obtain health information, most commonly using fitness and diet apps of any shape (Fox and Duggan, 2013). In

general, internet health information seeking is able to improve the patient-physician relationship (Tan and Goonawardene, 2017).

In 2002, five years before the launch of the first iPhone, Eng delivered a broad definition of the term eHealth. It was defined as „the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care” (Eng, 2002). It was lately adopted to also accommodate to the usage of mobile technologies to deliver care, which then is sometimes called mHealth (Nacinovich, 2011). Today however, there is growing disparity among scholars as to what should be subsumed under the term eHealth and its related terms. Its meaning might vary between research institutions, although a standardized definition was provided by the WHO in 2006 (Lewis, 2015). The same is true for the term telemedicine. In 2014, a group of 100 specialists,

partaking in the Federal Telemedicine Work Group announced by the U.S. Department of Health and Human Services, came up with seven unique, yet all slightly diverging definitions of telemedicine (Doarn et al., 2014). eHealth and mHealth, however, are sometimes also used instead of or synonymously to the terms telemedicine or telehealth. Consequently, there is a strong need for both empirical and practical definitions as a basis for further research of any kind.

Despite this uncertainty regarding the definition of eHealth, there seems to be a remarkable scientific consensus about what to expect from this technology. Eng (2002) formulates the somewhat vague hope that eHealth might improve healthcare, and, thereby, ultimately health itself. Other authors have gone far beyond that. In an attempt to adapt the ten “E’s” concerned with eCommerce to the domain of eHealth-technologies, Eysenbach assumes that eHealth might enhance quality of care, while also creating a previously unknown knowledge basis for each patient. This might in turn empower patients to make more informed decisions about their health or treatment. According to Eysenbach, this will ultimately encourage an all new relationship between patient and caregiver (Eysenbach, 2001).

The evident gap in scientific research described above is intended to be closed by targeting the disparity in definitions and therefore the inconsistent application of the terms telemedicine, telehealth, eHealth, and mHealth.

The aim of this paper is to develop a consolidated view (1) to define the individual terms and (2) to synthesize their interrelations and delimitations. A terminological ontology is specified in this paper. It serves as an instrument for eHealth-researchers to monitor adequate applications of related terms.

For facilitating a common understanding, ontologies are a widely-used tool in a great variety of domains as they allow a specification of domain concepts and the relationships among them in a formalized manner. Therefore, they offer the possibility to describe domain knowledge and the semantics of terms. In technical applications, e. g. in the field of computer science, health informatics or biomedicine, knowledge modelling ontologies are used to create knowledge bases, which in turn serve as the foundation of decision-support systems (Heijst, 1997), e. g. for medical emergency coordination (Sujanto et al., 2008). However, other types of ontologies are used to specify taxonomies across different domains (terminological ontologies, Heijst, 1997) in order to facilitate semantic interoperability, such as Open Biomedical Ontologies, SNOMED

Clinical Terms (Ganzha et al., 2016) or the Gene Ontology (The Gene Ontology Consortium, 2000). In contrast to this data-centric application of ontologies, the focus of this paper lies on discussing the general relations of concepts in the eHealth and telemedicine domain.

2 METHODS

The inclusion of terms was conducted starting from the concept of eHealth. A literature study in the field of healthcare and connected fields (e. g. health informatics or health communication) was carried out to identify the relevant definitions, starting with those concerned with eHealth. In a next step, related concepts such as telemedicine, mHealth, telehealth as well as ICT, telematics, and digitization were included. These interrelated terms were introduced and explained to achieve a broad understanding of the surrounding domain.

Based on an overview of established definitions, a coherent definition of and the relations between the terms are derived. The resulting interrelations and delimitations are illustrated in an ontology. Identified conflicting definitions and relations between terms are discussed. Afterwards, a terminology concerning eHealth and healthcare related terms is proposed. The paper ends with a summary and an outlook on further research.

3 DEFINITION OF RELEVANT TERMS

The literature analysis starting from the term eHealth yielded several terms of the healthcare domain. As eHealth is largely based on technology, the research presented here began with exploring the technology-related terminology. The identified terms and concepts as well as their dependencies are depicted as a terminological ontology in Figure 1. The terms and concepts are shown as nodes in the diagram. The different edges connecting the nodes represent the relationships between the concepts. Their semantics, based on the UML class diagram notation, are added as labels. References containing the definitions of concepts and justifications for the relations were added to each element in the diagram.

It was observed that the analysed terms and their relationships are defined to different degrees of consistency in the research community. To indicate this, debatable relations are depicted in italic style.

In the following section, definitions and explanations for the different concepts represented in the proposed ontology are provided. Consistent definitions for the terms **digitization, information and communication technology** as well as **telematics** were identified.

The increasing level of **digitization** affects every area of society. The use of digital instead of analogue signals, besides changing the way of people's work, also broadens the abilities of technological systems (Hagen, 2017). To enable digitization and its diffusion in all areas of life, the use of information and communication technology (ICT) is required (Hagen, 2017).

Information and communication technology “refers to both different types of communications networks and the technologies used in them. [...] [It] fulfil[s] or enable[s] the function of information processing and communication by electronic means” (OECD, 2014).

Strongly related with ICT and also used in the healthcare sector is the term telematics. **Telematics** combines the theories of telecommunication with informatics (Alpay and Heathfield, 1997). This concept plays an important role for healthcare as it describes “the transmission of information across distances” (Alpay and Heathfield, 1997). For this reason, it also enables changes in the way care is delivered (Dasgupta and Deb, 2008).

Concepts like **eHealth, mHealth, telehealth**, and **telemedicine** are among these new ways of care delivery. All of them introduce technical components into the domain of medicine, health and wellbeing. Apart from this common denominator, controversial definitions of the terms were found.

eHealth, for example, “refers to tools and services using information and communication technologies that can improve prevention, diagnosis, treatment, monitoring and management” (EC, 2015). In addition, it also supports care provision using different new services and systems, such as electronic health records or telemedicine services (EC, 2015). eHealth is therefore mostly related to healthcare by involving professional service providers as well as focusing on patients and their (everyday) behaviour and lifestyle.

Telemedicine, in contrast, is exclusively focusing on aspects of healthcare: The European Commission (2015) and Sood et al. (2007), who reviewed 104 different definitions of telemedicine, conclude that telemedicine is part of eHealth. The use of ICT over distances to deliver “healthcare services and medical education” (Sood et al., 2007) is characteristic. The involvement of professional

service providers is therefore obligatory for telemedicine services (WHO, 1997). Among the 104 studies reviewed by Sood et al., there are important differences in the understanding of telemedicine, pointing out the existing heterogeneity of the terminology: Telemedicine may “range from simple e-mail-based store-and-forward technologies to complex remote surgical technologies that employ robotics” (Sood et al., 2007). Following the European Commission (2015), this understanding describes the term eHealth instead of telemedicine.

Unlike telemedicine, **mHealth** describes “the use of mobile communications for health information and services” (Nacinovich, 2011), which is possible without the direct involvement of health service providers. Especially the transmission of health information using mobile communications can be carried out exclusively by the patients themselves (PWC, 2013). In general, it has to be pointed out that mHealth is not a well-defined concept. Nacinovich (2011) is one of few authors who proposed a definition, which, however, is still quite broad.

Another concept related to the considered terms is **telehealth**. While Sood et al. (2007) define it as a generic term for telemedicine, the World Health Organization (2010) describes both terms as being equivalent. Nevertheless, both terms can also be distinguished based on the involved healthcare providers: Telemedicine can be seen as a service exclusively delivered by physicians (WHO, 1997), while telehealth includes the delivery of services by all existing healthcare providers (WHO, 2010). Yet, it is stated in the WHO group consultation on telemedicine from 1997, that “health telematics” as the broader term is not restricted to any involvement of health professionals, as it also includes the generic term “health-related activities” (WHO, 1997).

Considering the uncertainty about how to adequately define and delimitate the terms telemedicine and telehealth, a decision about their hierarchical relationship is difficult but nevertheless required. To this end, the distinction between health and wellness may serve as an additional indicator to resolve this uncertainty.

While health and wellness are often used interchangeably, different meanings are established ever since the WHO first defined **health** as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (WHO, 1948). It is the word “complete” that has led to criticism of the WHO definition, for it is said to make it overly inclusive (Stoewen, 2015). Nevertheless, as Stoewen points out, this broad scope acknowledges the fact that health does not

only depend on environmental or socio-economic factors, but also on the individual’s lifestyle and therefore on wellness (Stoewen, 2015).

The individual’s responsibility for his or her wellness is embodied in the definition by the U.S. National Wellness Institute, which considers **wellness** “an active process through which people become aware of, and make choices toward, a more successful existence” (National Wellness Institute, 2015). Apart from the individual responsibility advocated here, it also becomes clear that wellness can not only be achieved with the aid of a health practitioner, as it is also reflected in Kirch’s (2008b) definition of well-being. On the other hand, healthcare delivery, used synonymously to medical services, is also defined as prevention and treatment of diseases through the healthcare system (Kirch, 2008a). The latter embodies health professionals of any shape.

In conclusion, health according to the WHO’s early definition is a state of holistic well-being, while wellness is the individual’s way to preserve and enhance that state (Stoewen, 2015).

For their systematic review on health and wellness technologies used in underserved areas, Montague and Perchonok (2012) rely on the same holistic definition of health and the understanding of **wellness technologies** as having “little or no interaction with the health care system” (Montague and Perchonok, 2012). Instead, they take technologies primarily used by the consumer into account, thereby paying their respect to the individual’s responsibility embodied in the term wellness.

As previously mentioned, contradicting definitions exist for some of the investigated terms. Especially the scope of eHealth, telemedicine, and telehealth can be conceived differently. Due to the

diffuse separation between the terms themselves, a strong overlap can be recognised. Accordingly, the terms telehealth and telemedicine can be further differentiated by applying them to the concepts of health and well-being/ wellness. While eHealth and telehealth use a holistic understanding, telemedicine focuses on medical and diagnostic elements requiring the involvement of physicians.

A conclusive assessment of the various definitions is not part of this paper, but it is one of the topics that were identified for further research.

4 RELATIONSHIPS BETWEEN THE CONSIDERED CONCEPTS

In the following section, the aim is to explain and justify the relationships in the developed ontology using definitions and logical reasoning. The result is shown in Figure 1.

For the implementation of digitization, ICT is needed (Hagen, 2017). Therefore, both terms have a connection, with digitization being the dependent term. Another connection regarding ICT is to telematics. Telematics is enabled by ICT and therefore depends on it (Alpay and Heathfield, 1997). On the other hand, telematics is an enabling concept for eHealth. Due to the possibility of overcoming distances on the basis of ICT, it is a foundation for eHealth and related concepts (EC, 2015; Sood et al., 2007).

At the same time, eHealth is a generic term for different related concepts. Even though mHealth is not defined conclusively as a whole, it is nevertheless defined as a part of eHealth as it does not necessarily involve service providers (Nacinovich, 2011), as it is the case for telehealth and telemedicine.

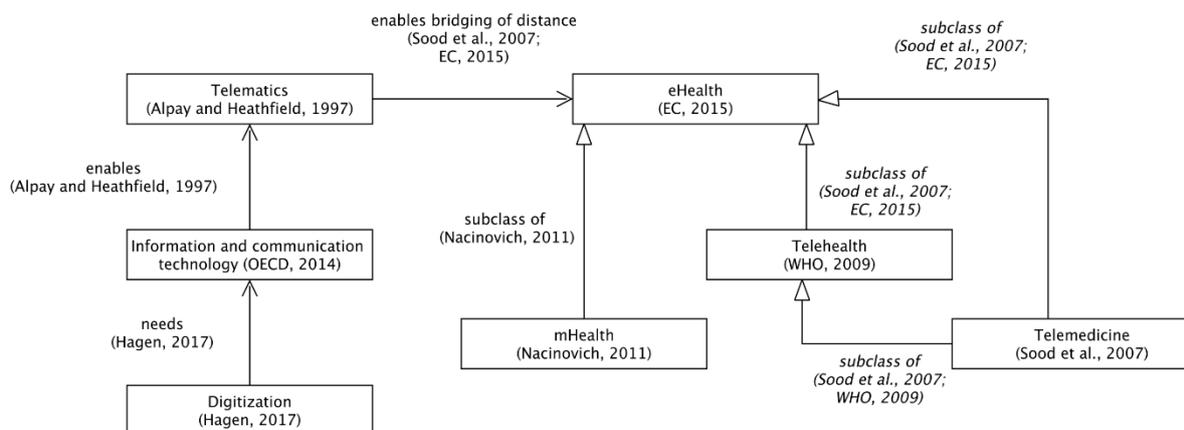


Figure 1: Terms and relations based on literature analysis.

As described with the definitions above, telemedicine can be seen as a subcategory of telehealth (Sood et al., 2007) and eHealth (WHO, 2010) at the same time. Resulting from both views, as they exist simultaneously, telehealth needs to be a subcategory of eHealth while being a general term encompassing telemedicine.

Especially the relationships between eHealth and telemedicine as well as telemedicine and telehealth are not defined consistently. A logical separation is possible based on their focus on either health (telemedicine) or both health and wellness/ well-being (eHealth, telehealth). However, on the basis of a diffuse separation between the particular terms, the delimitation between them is not clear as well. In order to illustrate this, these relations are depicted in italic style in Figure 1.

Nevertheless, each term and relationship was justified by at least one definition. Despite the fact that an ontology for the main terms is provided, a lot of different meanings regarding some terms and their delimitations will remain. Hence, our explicit description of existing relationships provides a consistent basis for further work.

5 NEXT STEPS

So far, the ontology provides only a technological point of view. A next step can be a connection to “real life”, which mainly includes different care models and their relevant stakeholders. As digitization affects

every area of life (Hagen, 2017), eHealth along with related technologies and concepts directly affect human beings. Within the grey box in Figure 2, a proposal for the integration of patients and other stakeholders into the provided ontology is displayed.

Telemedicine as a concept of care cannot be conceived without the underlying care processes, e.g. **care models**. Care models exist as a combination and interaction of different participants, such as **service providers**, who treat **patients** and get paid by **funding agencies**. The components of care models show a certain variability (WHO, 2016). Depending on the primary objective of a care model and its target disease or population, it varies to a considerable extent (Broese van Groenou and Boer, 2016; Davidson et al., 2006; Wagner et al., 1996). Consequently, detailed analyses and further discussions are needed to develop an evidence-based link of care models with the developed ontology.

As represented in Figure 2, the terms are justified by definitions. Only funding agencies were not found to be adequately defined. Because our focus is on the German health system, a specific definition regarding funding agencies needs an enhanced examination, taking into account the framework of the German health system. Finding an appropriate definition and further justifying the proposed relationships with applied care provision (see grey box, Figure 2) will be addressed in future research. Taking the current ontology as a foundation, the goal is to further develop it to a reliable and scientifically proven ontology for eHealth and related terms,

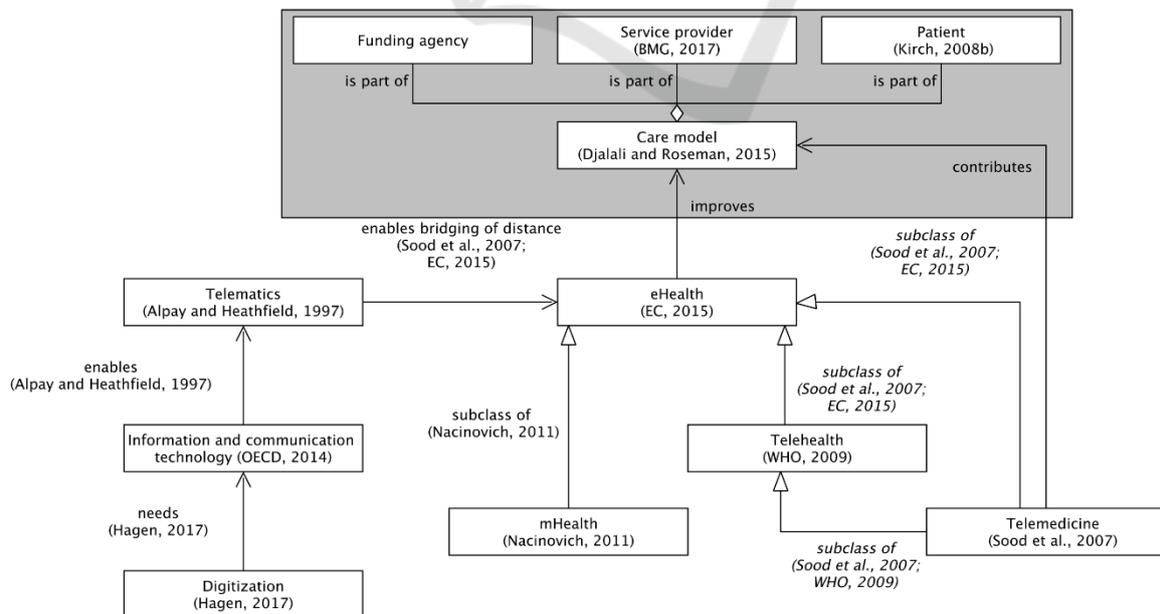


Figure 2: Proposal on how to connect the health care domain to the terminology.

especially with respect to patients. A potential way to validate the provided ideas is to conduct an expert workshop as suggested by Gammon et al. (2015).

6 CONCLUSION AND OUTLOOK

Due to the identified heterogeneity and uncertainty regarding the definitions of eHealth and related terms, the focus was on the provision of a consolidated view for interdisciplinary studies. Furthermore, this consolidated view can help to understand and support quality assessments and facilitate the diffusion of innovative care concepts into practice.

To reach this aim, a terminological ontology was created via a two-step procedure. Firstly, the underlying technological concepts of eHealth and related terms were identified using an extensive literature analysis. Secondly, a proposal was made to extend the ontology and to include care models, by conducting a literature analysis. Finally, an outlook was developed describing next steps to validate and further develop the provided ontology.

All in all, an overview of eHealth, telemedicine, telehealth, and mHealth as well as related terms could be provided. Nevertheless, it was found that for some terms insufficient definitions (e. g. mHealth) and unclear delimitations are prevalent in the research community. Especially the connections between telemedicine, telehealth, and eHealth need to be clarified.

Systematic reviews for additional terms in the proposed ontology-extension (Figure 2) should follow, in order to establish definitions substantiated by the research community and infer appropriate relations. Moreover, it needs to be verified if all adjacent concepts are already represented in the ontology proposal, as e. g. the term digitization also possesses a processual character, which possibly impacts additional concepts.

The presented work is intended to further enhance discussion and thereby improve the quality of telemedicine research and innovation. As a result, this work is a valuable contribution to eHealth research as it contains theory- and evidence-based knowledge of the domain terminology. It reveals the importance of a common terminology and it therefore provides the foundation for an interdisciplinary understanding.

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