Bringing Telemedicine Initiatives into Regular Care: Theoretical Underpinning for User-Centred Design Processes

Completed Research Paper

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Abstract

Telemedicine is said to change the way care is delivered. Nevertheless, it still faces barriers to overcome the pilot stage and reach a majority of patients in regular care. Missing consideration of user-centred design processes is one major reason for this development as individuals are a key component for the technology's success. Therefore, we aim to provide recommendations for a user-centred design process, which is, in turn, crucial to successfully implementing telemedicine innovations. To reach this aim, we identified individual-related barriers for telemedicine with an umbrella review. Furthermore, we related the barriers to the Unified Theory of Acceptance and Use of Technology (UTAUT2) proposed by Venkatesh and colleagues. A theoretical explanation helps to generate a broader understanding of what prevents individual acceptance of telemedicine innovations. The provided recommendations are supposed to support researchers and practitioners planning future telemedicine solutions.

Keywords: Theory of acceptance, adoption, use, individual

Introduction

Telemedicine promises to improve care especially for individuals in medically underserved areas (Bashshur et al. 2000; Jang-Jaccard et al. 2014) by delivering healthcare services and/or medical education over distance with the use of information and communication technology (ICT) (Sood et al. 2007). Although it has been subject to research and practice for more than half a century (Singh et al. 2002), it seldom overcomes the pilot stage (Boonstra and van Offenbeek 2010; van Dyk 2014) and only a minority of patients benefit from its promise (Brauns and Loos 2015).

Telemedicine mandatory involves professionals that take measures to preserve or restore the individual's health (Sood et al. 2007). As users of technological innovations, individuals have a huge influence on the innovation's success (Boonstra and van Offenbeek 2010; Klecun-Dabrowska and Cornford 2000). The individual recipients and providers of telemedicine play a key role in the diffusion of telemedicine, i.e. its application in regular care. Diffusion describes the process when a majority of potential users decides to take full advantage of, i.e. accepts, an innovation (Zanaboni and Wootton

2012). That being said, acceptance of the individual end-user is a non-negotiable precondition for the diffusion of any technological innovation (Rogers 2003).

Therefore, enabling telemedicine solutions to reach regular care requires a focus on the end users while putting emphasis on their characteristics and needs (Hastall et al. 2017). Current acceptance research for telemedicine or eHealth solutions mainly takes the properties of the technology into account (Gagnon et al. 2016), but lacks a consideration of the end user's characteristics (Riley et al. 2011). Behaviouristic models and acceptance theories are an instrument to split users' acceptance decisions into facets that can easily be addressed (end user and technological characteristics as well as environmental influences). Yet, design processes of telemedicine solutions often lack a theoretical foundation (Band et al. 2017), even though it is a vital part of several guidelines, e.g. by the Medical Research Council (Craig et al. 2013).

The Unified Theory of Acceptance and Use of Technology (UTAUT2) by Venkatesh and colleagues (Venkatesh et al. 2012) is one theory that incorporates widely accepted behaviour theories as well as existing models of technology acceptance. Its general premise is that acceptance is a function not only of technological components but also of individual traits and attitudes towards the technology. In addition to its predecessor, the UTAUT, it also covers individual experiences such as habit and hedonic motivation for technology use. Additionally, it considers the costs arising for the individual and focuses less on organisations but on individuals as the units of acceptance. The UTAUT2 is widely used for studying technology acceptance, e.g. of electronic health records (Tavares et al. 2018), but was, to the best of our knowledge, not yet applied to the acceptance of telemedicine solutions as narrowly defined as for this paper (to address the delivery of care to the patient over a distance).

The aim of our research is to derive recommendations for those planning telemedicine programs, be they researchers, telemedicine project managers or healthcare providers. To reach this aim, we identify barriers for telemedicine acceptance using a systematic review of reviews (Aromataris et al. 2015) and arrange them in the context of UTAUT2 based on consensus meetings. This helps to successfully address currently existing barriers and to close the gap of lacking theoretical underpinning in telemedicine systems design by providing theory-based recommendations for future design processes.

The matching of barriers with the factors of the UTAUT2 also serves as an operationalisation for them. Operationalisation is necessary where factors cannot be measured directly. The results can then be used by future researchers as a framework for designing structured questionnaires or semi-structured interview guidelines for end user acceptance.

Matching systematically derived barriers with a widely accepted theory will also support testing whether the UTAUT2 is a useful theory to explain individual's telemedicine acceptance. Even though various taxonomies of telemedicine and related technologies, such as eHealth, exist (Bashshur et al. 2011; Fitch 2004; Tulu et al. 2005), we aim to provide a holistic assessment of barriers which does not relate to specific phenotypes. With respect to the special setting of care delivery, possible additions to the UTAUT2 are proposed where necessary.

The remainder of this paper is structured as follows: In the next section, we present the theoretical background before explaining the method. Afterwards, we match the identified barriers with the UTAUT2 and discuss the results and their implications for research and practice.

Conceptual Basics

The adoption and diffusion processes are influenced by a variety of factors, which can, if not sufficiently considered, become barriers for the process itself. "Barrier" in our case is defined as "a circumstance or obstacle that keeps people […] apart or prevents […] progress" (Oxford Dictionaries n.d.). While innovation acceptance is called "adoption" (Rogers 2003), behaviour theories and acceptance models describe the same process as "acceptance" (Schwarzer 1992). Both words are used interchangeably in the following.

Different acceptance models and theories of behaviour change aim to describe the factors and processes of technology acceptance and use. Among them, the UTAUT is a useful approach, as it combines the technological perspective with the individual user's perspective (Venkatesh et al. 2003). Taking the

UTAUT as a basis, the UTAUT2 further extends the original version by focussing on the consumer itself as an individual, not an employee of his/her organisation. Providing a tool for assessing new technologies regarding their likelihood of being adopted by the end user and deepening the understanding of acceptance drivers, the UTAUT2 can help generate further insights into telemedicine acceptance. Upon further extending the UTAUT, which is based on eight acceptance models and behaviour theories (Venkatesh et al. 2003), seven factors were identified as significant determinants of generating user acceptance: performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value and habit. Most of these factors (except facilitating conditions and habit) will not automatically lead to telemedicine use behaviour without the mediator "behavioral intention", referring to the individual's willingness to use the application, being present. Furthermore, age, gender, and experience serve as key moderators (indirectly) influencing the positive use behaviour as final goal to be achieved (Venkatesh et al. 2012).

Research Method

We conducted a systematic review of reviews, also called "umbrella review" (Aromataris et al. 2015), in order to identify barriers for telemedicine interventions. We refrained from a focus solely on publications in leading journals to avoid bias (Webster and Watson 2002) and instead searched by topics across relevant databases: PubMed/Medline, as it is the largest and most inclusive database in the medical field; Cochrane Library, because it focuses on reviews; APA PsycNET, as behavioural research is assumed to be found in a database for psychology; and Academic Search Complete (EBSCOhost), as it is expected, due to its interdisciplinary character, to cover the research areas that are not included in the previous databases. The search string consisted of a combination of "telemedicine" or related terms (telehealth/eHealth) (Bashshur et al. 2005; European Commission (EC) 2015; Sood et al. 2007; World Health Organization (WHO) 2016), "barrier" or tested synonyms as well as "rural" or "underserved" and "review". The focus was put on telemedicine solutions for individuals who have little or no access to care, which refers to people in rural or underserved areas. While this might narrow the focus, it pays respect to another dimension of telemedicine acceptance: Where technology is possibly the only chance to receive continuous health care, it is of even higher importance for this technology to be designed according to the needs of the end user (Brooks et al. 2012). To prevent our research from being limited by different definitions (e.g. patients, actors, stakeholders) of the involved individual (Boonstra and van Offenbeek 2010; Simpson and Reid 2014), all reviews reporting barriers, such as financial or organisational, were included.

The search led to 198 results. After duplicate removal, titles and abstracts were read to ensure that the reviews met the inclusion criteria. Reviews were included if they are referring to studies that analysed telemedicine or related technologies in terms of barriers for implementation. Afterwards, the remaining full texts were also checked for meeting the inclusion criteria. Due to the inclusion of all kinds of reviews (e.g. systematic, literature or meta reviews), a quality assessment (Oxman and Guyatt 1991) was conducted to only include methodologically sound reviews. The Overview Quality Assessment Questionnaire (OQAQ) consists of 10 items rating different aspects of scientific quality with zero, one or two points per item (Greaves et al. 2011). As we included all kinds of reviews (among them also scoping and narrative reviews), we did not apply the item on methodological quality of the included primary studies. In our modified version of the OQAQ, 16 points can be reached at maximum. All studies with a minimum of 13 points were included in our assessment (corresponds to same percentage as in original OQAQ). An example for OQAQ dimensions is the question about reasonable comprehensiveness, i.e. whether the search conducted took place in more than one database. An overview of the selection process can be seen in Figure 1, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart (Moher et al. 2009). All authors read and assessed titles, abstracts, full texts and did the quality assessment independently from each other. Inconsistencies between the ratings were resolved through discussion and consensus.

As the number of included studies is rather small, no Cohen's Kappa or Krippendorff's Alpha was calculated.

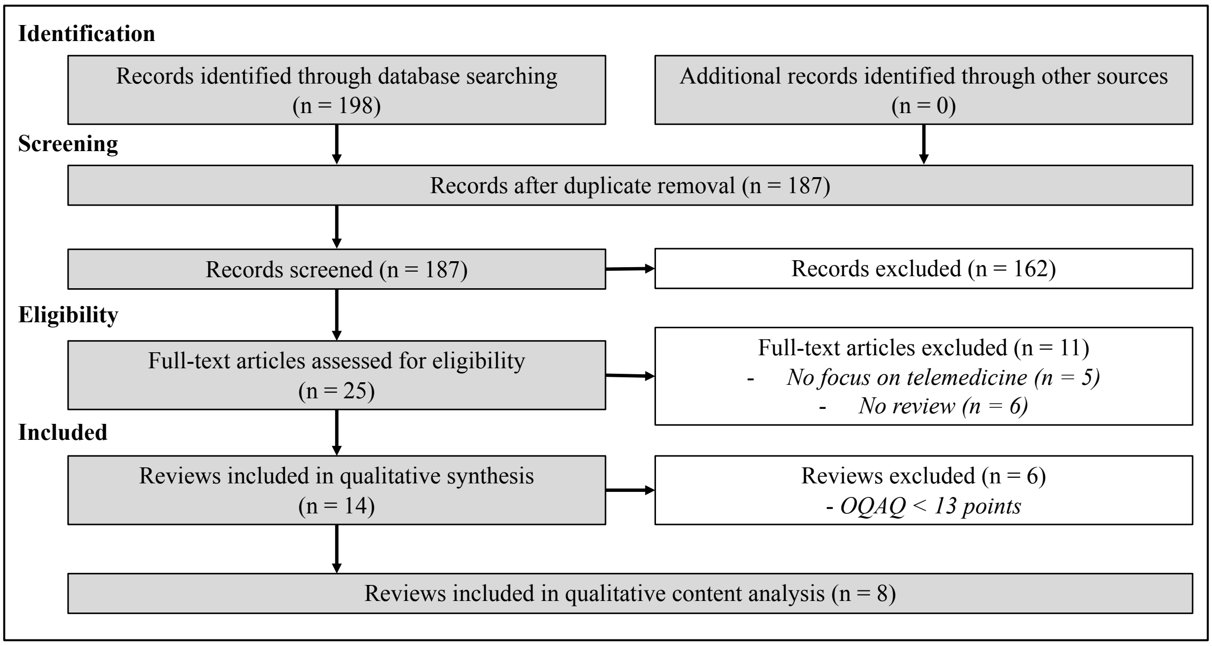

Figure 1: Flow of information according to PRISMA (Moher et al. 2009)

As a next step, barriers related to the individual were identified within the eight remaining articles (Fitzner and Moss 2013; Govender and Mars 2016; Gros et al. 2013; Hage et al. 2013; Jang-Jaccard et al. 2014; Kruse et al. 2016; Saliba et al. 2012; Simpson and Reid 2014). Every barrier was considered as related to the individual if the question "By addressing this barrier, does something change directly and positively for the individual's acceptance process?" was answered with yes. To clarify, logistic concerns, for example, are an individual-related barrier that can be addressed by the design of the application to make it easier to handle.

Finally, the list of individual-related barriers was matched in consensus meetings with the factors of the UTAUT2 proposed by Venkatesh et al. (2012) (see Conceptual Basics for all factors). The process was done individually. Whenever discrepancies regarding the allocation of a barrier arose, they were resolved through discussion between both authors.

Results

Data extraction from the eight relevant studies resulted in 98 different barriers of which 54 are individual-related (55.1%). Even though each study covered a different type of telemedicine solution, ranging from simple videoconferencing tools (Gros et al. 2013) to audiological assessment (Govender and Mars 2016) by using technology, analysis of the barriers revealed broad categories which span all types of applications. Topic, reported method, no. of included studies and related OQAQ score are displayed in Table 1. Besides the focus on the individual which all of the barriers have in common, other factors of society are additionally responsible for these barriers. For a better understanding of each review and what areas it covered, we use the following factors to describe each included article: Patient, health care provider, the health care system, involved technology, used methodology as well as financial, cultural, legal and organisational circumstances.

No.	Topic	Reported method	Ref.	No. of incl. studies	OQAQ score
1	Barriers to effective telehealth support for diabetes self-management education	Literature review	Fitzner and Moss (2013)	12	13
2	Challenges for feasibility of telehealth for audiological management	Scoping review	Govender and Mars (2016)	23	16
3	Methodological challenges in evidence-based psychotherapy	Systematic review	Gros et al. (2013)	26	14
4	Restraining factors on e-Health service adoption	Systematic literature review	Hage et al. (2013)	51	16
5	Stakeholder-related barriers for telehealth adoption	Literature review	Jang-Jaccard et al. (2014)	18	13
6	Obstacles for the widespread adoption of telemedicine programs	Systematic literature review	Kruse et al. (2016)	15	14
7	Factors hindering the implementation of telemedicine across borders	Systematic review	Saliba et al. (2012)	94	16
8	Barriers to therapeutic alliance in videoconferencing psychotherapy	Systematic review	Simpson and Reid (2014)	23	15

Table 1: Characteristics of included studies

Patient-related barriers, e.g. lack of community's support, resistance to change or employment status, are named within all included reviews. Fitzner and Moss (2013) are the only authors in our review who additionally named legal barriers like requirement for provider certification, while Govender and Mars (2016) further extend the patient focus with technology-related barriers, e.g. missing functionalities or low connectivity. Besides patient and technology as reasons for barriers, Gros et al. (2013) further focus on health care providers. They point out that, for example, limited personal connection or relationship as well as fear of lower therapeutic alliance can prevent telemedicine solutions from being successful. Hage et al. (2013) cover the same general categories as Gros et al. but broaden the scope by adding financial and organisation-related barriers, such as high cost of technology or available alternatives for receiving services/information. The most extensive examination of individual related barriers is provided by Jang-Jaccard et al. (2014): Within their review, patient-, health care provider- and -system-related barriers are identified as well as barriers related to technology, methodology, finance, culture and organisation. This review adds, among others, barriers like lack of confidentiality or reliability, lack of motivation, workforce shortage or lack of broad scope. The reviews by Kruse et al. (2016) and Saliba et al. (2012) name only individual-related barriers that are influenced by the patient, health care provider, technology, finance or culture. Examples are language (Saliba et al. 2012), fear of loss of system control (Saliba et al. 2012) or no funding for patients (Kruse et al. 2016). Finally, Simpson and Reid (Simpson and Reid 2014) focus solely on patient- and health care provider-related barriers by adding, for example, privacy concerns to the list.

Except for "employment status" and "health status", all individual-related barriers could be categorised into the UTAUT2. In Figure 2, the final model is represented. The bold headings are the initial predictors of the UTAUT2. In order to have distinct measurements for each UTAUT 2 predictor, no barrier was matched with more than one predictor.

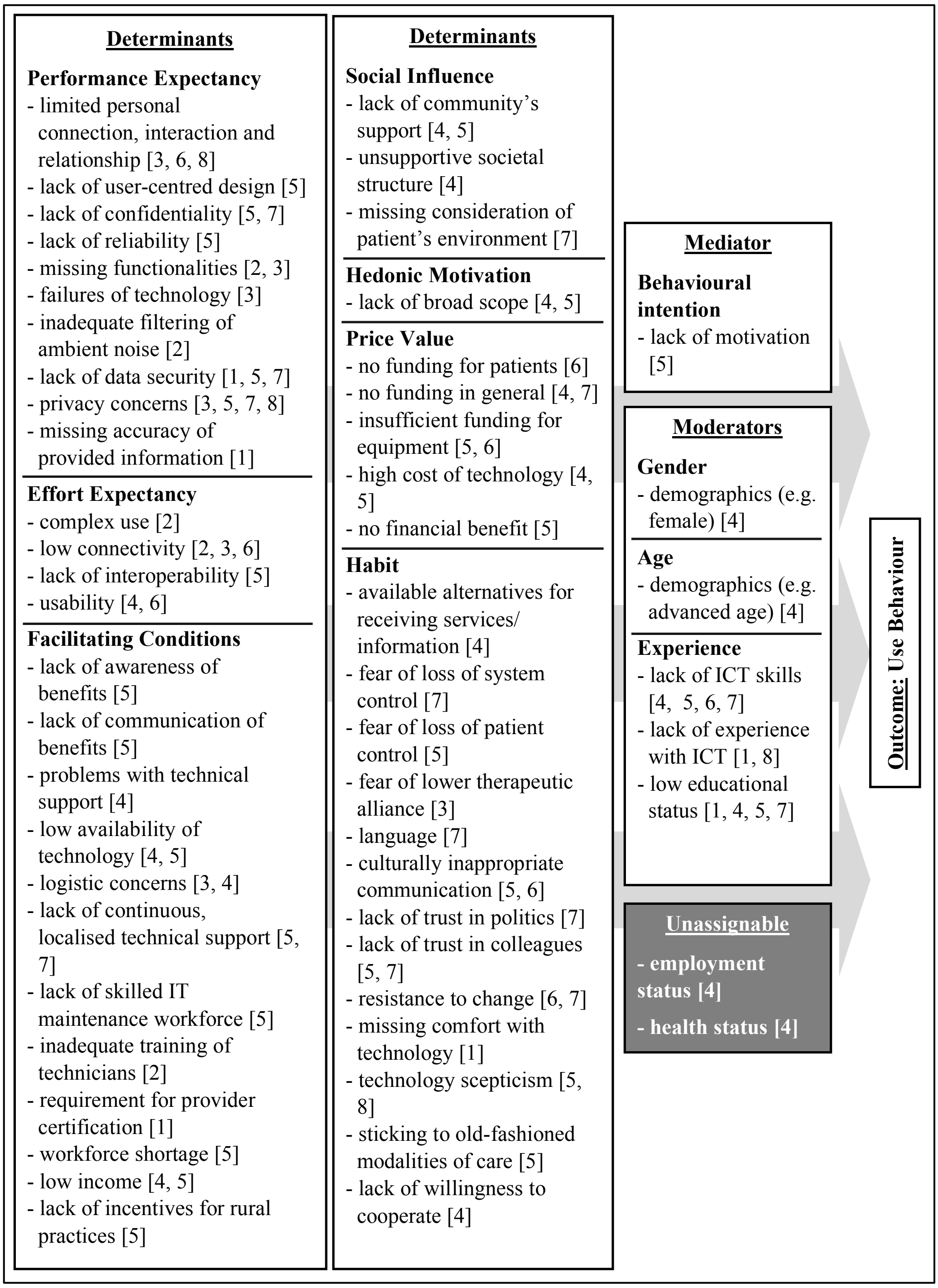

Figure 2: Assignment of individual-related barriers to the factors of UTAUT2 – references according to numbers in Table 1

All factors of the UTAUT2 are represented by at least one of the individual-related barriers. Thereby, the determinants form the largest group (48 barriers – 88.9%) followed by the moderators (5 barriers – 9.3%) and the mediator (1 barrier – 1.8%). Moreover, it can be seen that over two third of all barriers (68.6%) belong to the determinants "habit", "facilitating conditions" or "performance expectancy".

The categories subsumed under the factors of the UTAUT2 (except age and gender) serve as an operationalisation of the model for future quantitative research. For example, our model shows dimensions of measurement for the factor "price value": By asking whether funding is sufficient in general as well as for patients, equipment and technology, and whether financial benefits for the end user exist, "price value" gets measurable.

Discussion

With 54 out of 98 barriers being related to the individual as the end user – be they patients or healthcare providers – this category accounts for more than half of all barriers found. This figure is similar to the one reported by Kruse et al. (2018).

Conclusively, the barriers found, as far as they are related to the individual as the end user, could all be matched to factors within the UTAUT2, a widely used technology acceptance theory. Habit, facilitating conditions and performance expectancy were found to be the most important factors to explain individual behavioural intention and use behaviour. This also matches the results presented in the MOLD-US (mHealth for older users) framework, in which barriers for older adults were evaluated which hamper usability of mobile telemedicine solutions (Wildenbos et al. 2018).

However, socio-demographic variables within the model are limited to the purpose of explaining telemedicine use. Employment status, as it accounts for a lack of resources necessary to afford health technologies, is completely missing from Venkatesh et al.'s (2012) model. This is also true for the health status. Nevertheless, consideration of individual health status and the resulting individual risk assessment in implementing new telemedicine services is crucial. Since the UTAUT2 has not been set up to explain the use of health technologies, let alone telemedicine, it is not surprising that these factors are not considered. With most of the barriers found closely fitting categories of the model, we conclude that the UTAUT2 can adequately explain health technology use after some minor additions are made: Health and employment status should be added as socio-demographic predictors (see Figure 3). Even though those additions are founded in only one of the included studies, previous research underlines the need to consider the perceived health status of the individual when studying his/her acceptance of telemedicine technology (Dou et al. 2017). As the employment status is closely linked to the costs of technology one can afford, its inclusion is in line e.g. with the determinant "price value". The applicability of the UTAUT2 shows that theories support a user-centred design process.

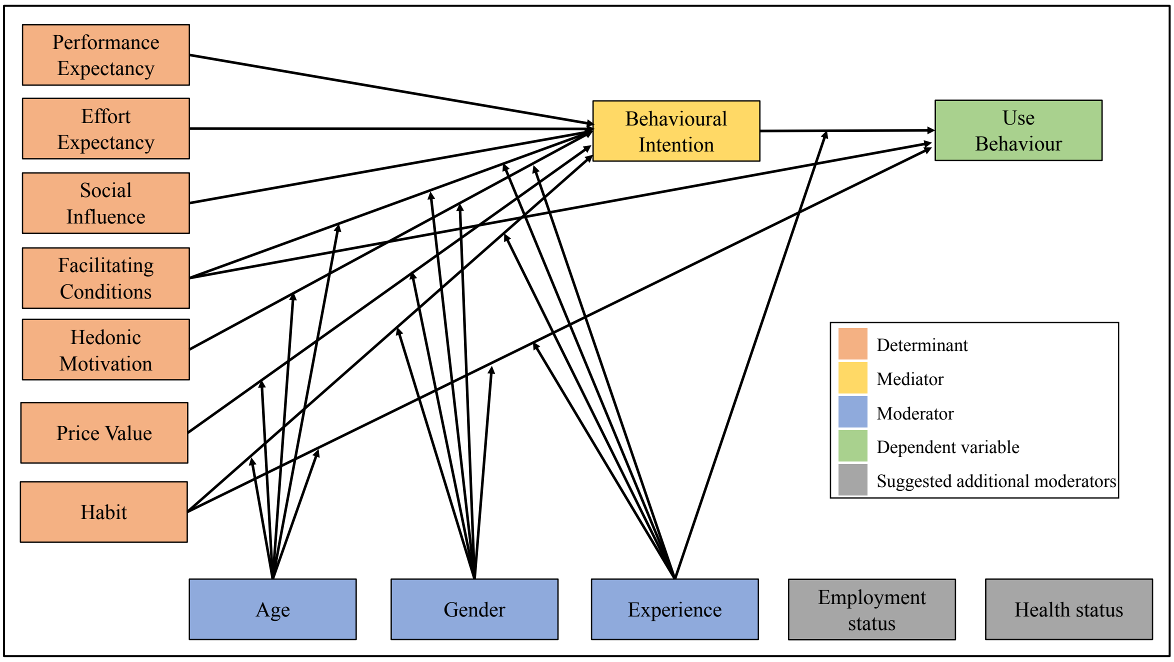

Figure 3: UTAUT2 with proposed extensions (presented in grey) - own representation according to Venkatesh et al. (2012)

Furthermore, relationships between the proposed predictors and the original UTAUT2 need to be tested for significance by quantitative research. The current qualitative results do not allow for the analysis of plausible further moderating relationships.

Limitations

The review itself is limited by the chosen search string and databases. A selection of other databases could have led to slightly different results. Nevertheless, related words were tested for results in the search string and the databases were included based on the fitting for our aim, which was the identification of individual-related barriers. Additionally, the quantity of studies investigated is relatively low. However, all included studies are of high quality. Also, the included reviews cumulate a high number of individual studies and seem therefore to be reliable. Cross-checking of individuals' barriers with the UTAUT2 is a subjective procedure but was strictly guided by the theory itself. Bias was also reduced by discussion and consensus as well as by cooperative work between the authors. Furthermore, evaluation of individual-related barriers was only done according to the quantity of findings, meaning that no barrier was weighed higher than another.

Contribution

Our work contributes to research and practice. For research, we showed that the individual is an important factor in a telemedicine application's acceptance and usage process, as more than 50% of all identified barriers are individual-related ones. However, these barriers are not caused solely by the individual and his/her expectations (esp. "habit" and "performance expectancy"), but also by "facilitating conditions", e.g. low availability of technology. Addressing the individual with his/her characteristics, needs and surrounding factors at an early stage of development is, therefore, crucial for the success of telemedicine applications. This is especially true for rural areas, where access to traditional healthcare is limited. Accordingly, third parties (e.g. relatives and local community) as well as the individual's social support play a key role in his/her healthcare services. Using the UTAUT2, which originates from the field of information systems, helped us to categorise individual-related barriers. During this process, we identified some limitations regarding the theory. We suggest some minor adjustments, i.e. adding employment status and health status to the theory. Applying the UTAUT2 and underlining the importance of the included factors leads to future directions of research. In particular, the determinants and the mediator need to be further focused on, preferably by quantitative research, to thoroughly understand and address their predictive effects. We showed that the UTAUT2 can, with the proposed adjustments, also be used for telemedicine solutions and barriers. In the original version by Venkatesh et al., the UTAUT2 accounted for 52% of the variance in technology use (Venkatesh et al. 2012, p. 171). With the proposed additions, future research should empirically test whether the predictive value of the model for usage of telemedicine solutions is equally high. Furthermore, when studying end user acceptance empirically, researchers should differentiate user groups such as elderly technology users and the so-called "digital natives", as some barriers might be of different importance for each group. Future questionnaires for studying end user's acceptance of telemedicine solutions should address the barriers subsumed under each latent determinant of the UTAUT2 as well as the two added constructs.

To practice, we contribute by identifying barriers and applying the UTAUT2 to the individual-related barriers. Based on that, we suggest habit, performance expectancy and facilitating conditions as most important fields of action.

In assessment practice, the importance of the patient perspective for the assessment of telemedicine devices has already been acknowledged, for example by the American Food and Drug Administration (Medical Device Innovation Consortium (MDIC) 2015). Therefore, we propose recommendations to address each determinant in the following. These recommendations are based on common practice and underlined by examples of studies supporting each recommendation (provided in brackets).

(1) Performance expectancy – The user should be placed into the centre of any development of telemedicine solutions. This could be done by analysing the market or surveying target patients prior to the development process (Lai et al. 2015). Only with this procedure, patient preferences can be addressed adequately.

(2) Effort expectancy – Any application prototype should be tested on possible end users within their natural setting. Qualitative research, such as focus groups and think aloud techniques are preferable (Ager et al. 2018).

(3) Social influence – The telemedicine solution must not isolate the individual within his/her relevant peer group. On the contrary, relevant third parties can support acceptance and sustained use of telemedicine solutions. Therefore, identifying and addressing closely related individuals or communities is crucial (Allam et al. 2015; Edwards et al. 2000).
(4) Facilitating conditions – The end user's environment should actively be considered as it can prevent the user from a voluntary decision to use a telemedicine solution. For example, a motivated end user can be prevented from considering a telemedicine solution as an alternative for standard care by a lack of funding or by his/her financial situation. Therefore, changing the regulatory conditions (which include finance) can also improve actively the user's facilitating conditions and conclusively his/her telemedicine acceptance. All in all, policy initiatives can further increase user acceptance (Jang-Jaccard et al. 2014).
(5) Hedonic motivation – Coping with the burden of disease should become easier with the telemedicine solution compared to the individual's usual habit of handling his/her disease. Therefore, apart from tests of effectiveness, usability testing should also be part of every telemedicine design process (Borycki et al. 2013).
(6) Price Value – Besides all the above-mentioned recommendations, which improve the telemedicine solution itself, the price of these recommendations needs to be calculated as inexpensive as possible. For every additional feature or measure, an individual weighing of costs and benefits needs to take place (Dixon et al. 2016).
(7) Habit – It became apparent that previous experience with ICTs (also in other domains) is an important factor to generate a basic readiness of the end user for telemedicine solutions. Where experience is lacking, high level of ease of use and/or increased training (delivered by technical support or the social environment) should be provided to close this gap (Gallos et al. 2014).

Redundancies in the proposed guidelines are due to the interrelations between some determinants, e.g. social influence and facilitating conditions, as both determinants partially involve third parties influencing the individual. We only address the determinants and not the moderating and mediating factors as they cannot be changed within the process of telemedicine development and implementation. Nevertheless, behavioural intention needs to be focused on by communication strategies incorporating the factors and recommendations listed above. Addressing a clearly defined target group is crucial. With this in mind, practical guidelines can be developed with and for practitioners to implement individual-centred telemedicine solutions. Please notice that some barriers for telemedicine applications can never be addressed, as the technology is not made for them or the surrounding conditions cannot be changed by the applications themselves. This applies for barriers like low income or employment status. Additional information on barriers not related to the individual can be found in another publication (Otto and Harst 2019).

Conclusion

All identified individuals' barriers, which represent more than half of all identified barriers, were further matched to the constructs provided in the UTAUT2 to explain the reasons for missing telemedicine acceptance and use. Nevertheless, employment and health status should be added to the UTAUT2 to make it more fitting for telemedicine technologies.

Our findings lead to a twofold contribution: On the one hand, telemedicine-related barriers are shown to be a complex and important topic, and the individual is a key factor in the acceptance process. Furthermore, we positively evaluated the UTAUT2 for telemedicine applications and suggested some extensions to further improve the theory for this particular field of research (e.g. focussing on health status as an influencing factor). In addition, our findings provide aspects for future research to focus on the identified barriers. Only with a broad understanding of what prevents individuals from using telemedicine can the effect on health and wellbeing be increased.

On the other hand, our proposed recommendations (1-7), such as testing any application prototype within the user's natural setting, can serve as a basis for practical guidelines and frameworks to successfully implement upcoming projects and promote more telemedicine projects to regular care.

Conclusively, our findings suggest that telemedicine applications do not need to remain stuck in the pilot stage but can be supported, especially by addressing the individual, even though some barriers will remain.

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