Deus versus Machina: How Much Health-supporting Technology Do People Allow Depending on the Severity of the Disease?

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Abstract: Changes in demographic structures resulting in more and more overburdened healthcare systems require novel solutions for modern societies. Members of aging populations are confronted with an ever increasing presence of diseases and seniors frequently suffer from morbidity, which leads to a higher demand of nursing care on the long run. Bottlenecks in this area can to some extent be relieved by the use of an assistive health-related technology, but its acceptance and use is entirely dependent on the targeted users. This study considers the perspective of severely ill persons regarding their nursing care and application of health-related technology support. Using scenario-based empirical research, participants of an online-study ($N = 585$) were confronted with three differently severe diseases and assessed aspects considered relevant for their nursing care and adoption of assistive health-related technologies. Results show significantly differing opinions in dependency on the severity of a disease. This study highlights several aspects that represent the perspective of diseased persons and provides valuable insights into accepted use of health-enabling technologies and preferred models of nursing care.

1 INTRODUCTION

While the growth of the world population on earth continues to rise sharply, in many societies people live now longer than some decades ago. The average age has been growing for many years, especially in the industrialized countries, and the trend remains unchanged for the time being. The declining number of younger people and the simultaneously increasing number of older people, however, continuously shift the demographic structures. Also in Germany, the demographic change has long since arrived (Statistische Ämter des Bundes und der Länder, 2011).

The increasing proportion of aged individuals in a population represents considerable challenges not only to the economic sector, but it poses especially challenging requirements to the feasibility and sustainability of healthcare (Fleiszer et al., 2015). As the probability of needing care increases with age, more and more people are in need of care as society ages. The result of this is that fewer and fewer young people are forced to care for growing numbers of older indi-

viduals, in many ways (Nowossadeck, 2013). Such a situation causes a rising burden of healthcare expenditures and leads in its consequence to a shortage of professionals trained to work with the aging part of the population. The more the population ages, the more it becomes an important issue of how we are going to pay for, and deliver, a quality care for the seniors (Rashidi and Mihailidis, 2012).

At the same time, rapid advances in the information technology enable new solutions that can, at least to some extent, alleviate the challenging situation of aging societies. In recent years, several integrative approaches have been developed, focusing on assistance of individuals – especially seniors, diseased, and impaired persons – in their natural home environments. Paradigms like pervasive computing, ambient intelligence, and ambient assisted living aim at empowering capabilities of humans by the means of digital environments that are unobtrusive, interconnected, sensitive, adaptive, and responsive to their needs (Sadri, 2011). Therein, a multitude of sensors and activators, applications, functions, single devices to whole systems are included. Smart homes which are equipped with such complex technology have a great potential to support their inhabitants and improve the quality of the time spent at home. Such technology-enhanced

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environments are intended to provide greater levels of independence for their inhabitants, and thus reduce the need for institutionalized nursing facilities by extending the time that people can live in their familiar surroundings.

In addition, information and communication technology (ICT) is increasingly being used in management of (chronic) illnesses. Some common ICT-applications, including home monitoring of vital parameters for chronically ill persons or communication via videophone consultations with medical staff, facilitate the professional services (e.g., electronic health records) as well as knowledge management, such as care rules, protocols, or scheduling (Celler et al., 2003). Jenssen et al. (2016) argue that there is a growing body of evidence that patient use of new technologies, enabling to communicate with healthcare providers, can lead to a behavior change and improved health outcomes. In this context, telemedicine, eHealth, and telecare are key applications for ICT in healthcare delivery which aim at specialist consultations and examinations of patients health state through the use of telecommunication.

With all the available technical solutions, however, cooperative behavior and a largely accepted interaction with the technology on the part of the persons concerned is indispensable. There is a great body of literature providing knowledge about applications for certain groups of diseases and, on the other side, about the success or failure in their deployment. In contrast, just a little is known about the willingness to use technology depending on the varying degrees of severity of diseases. Therefore, the present study focuses on the question how far persons suffering from severe diseases allow the use of ambient technologies which are meant to monitor their health and support them in managing their day-to-day necessities associated with their illness. In a scenario-based survey, we examined how the intention to use such assistive health-related technology is connected with emotional states of the persons concerned, who is allowed to have a say in respect of their therapy and rehabilitation, and what is the proportion of allowed care support on the part of human and on the part of technology.

2 RELATED WORK

In this section, the current research state on the acceptance of health-supporting technology innovations is presented, taking a broad variety of technologies into account. Also, the perspective of (chronically) ill persons and the relevance of nursing care is stressed and put in the context of the possibility to be supported by appropriate technical applications. Finally, the underlying research questions are introduced.

2.1 (Health-supporting) Technology and Its Acceptance

In view of the rapid development of technologies in various fields, acceptance and use of innovations in the area of information technology (IT) has been a major concern for research and practice. Over the last several decades, many theoretical models have been proposed and validated in different contexts to examine the acceptance and to predict the use and long-term adoption of particular innovations as reliable as possible. The most prominent models were the Diffusion of Innovation Theory (Rogers, 1983), Theory of Planned Behavior (Ajzen, 1991), Technology Acceptance Model (TAM; Davis, 1989; Davis et al., 1989), and Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003, 2012), which have been proposed, examined, and extended, providing factors which are able to explain to a great extent the acceptance and use of different technologies. However, even though the most dominant theoretical frameworks in the recent years – TAM and UTAUT – are very robust technology acceptance models, they have also received criticism for disregarding the possible fluctuation over time (Peek et al., 2014).

For the present study, especially the context of health-related technologies, and therein mainly (ambient) assistive technologies and systems, are gaining particular interest as their primary objectives are to monitor the health of the residents – mostly elderly and impaired persons – and ensure an appropriate data exchange as well as communication with physicians, caring staff, and families. To provide a smoothly operating health-related technology that is able to detect critical situations, such as falls, relevant changes in the individuals' behaviors, and/or sleeping patterns, a high degree of technology acceptance as well as consideration of the users' privacy concerns and expectations is required (e.g., Kirchbuchner et al., 2015; Schomakers and Ziefle, 2019).

As research in this area has shown, acceptance of medical assistance devices or systems, which predominantly address the senior part of the population, is associated with a multitude of factors that play a significant role. However, little is known about whether or not older adults are ready to adopt and use them (Jaschinski, 2014). In their review, Peek and colleagues identified 27 factors influencing the acceptance of electronic technology for people who are aging in place and divided them into six clusters: i. con-

cerns regarding technology, ii. benefits of technology, iii. need for technology, iv. alternatives to technology, v. social influence, and vi. characteristics of older adults (Peek et al., 2014). Nevertheless, a bulk of these factors have not yet been tested in a quantitative way. What has been substantiated by research, however, is that acceptance of medical technologies depends on perceptions of technology-related benefits and barriers. Many studies in this context provided evidence that assistive technologies were mostly assessed favorably, whereas for elderly people and those in need of care such benefits, like independent living, feeling of safety, monitoring of health, and possibility of staying at the own home, are especially appreciated (Wilkowska, 2015; Gövercin et al., 2016). Yet, perceived obstacles can also cast a shadow over the motivation for the use of assistive technologies. One of the most decisive barriers are concerns referring to privacy (e.g., Yusif et al., 2016; Wilkowska et al., 2015), which is a highly complex concept that involves different perspectives and dimensions (Little et al., 2007; Schomakers and Ziefle, 2019). The desire for privacy largely depends on the context and the individual attitudes (Bergström, 2015), but regarding the assistive technology it has also been showed to vary between different groups of individuals, like gender groups or groups referring to the users' health conditions (Wilkowska and Ziefle, 2012), culture (Alagöz et al., 2011), as well as social and physical environmental factors (Himmel and Ziefle, 2016; Schomakers and Ziefle, 2019). Other frequent barriers referring to the acceptance of ambient technologies include, among others, fears of surveillance and isolation from social contacts (van Heek et al., 2018), use of specific types and placements of the technology (Himmel and Ziefle, 2016; Kirchbuchner et al., 2015), perceived control over the technology (van Heek et al., 2017), trust, and the context of use (Montague et al., 2009; van Heek et al., 2016; Wilkowska and Ziefle, 2018).

Given all the factors known to impact the health-related technology acceptance and considering the fact that in the given context the technology adoption addresses especially the seniors, as they frequently suffer from multi- and comorbidity, the question arises if technology acceptance is significantly influenced by the severity of diseases.

2.2 Use of Health Information Technologies for Diseases

Almost everyone wants to live as long as possible independently at home. However, age-related increase of the probability for diseases and loss of functions in persons aged 65 years and older frequently leads to an ever greater loss of this autonomy (Böhm et al., 2009; Barrett, 2011).

Older adults in this stage of life are likely to suffer from one or more (chronic) diseases (Marengoni et al., 2011), experience changes of the immune system and the endocrine system, which are associated with disability, poorer health outcomes, and lower quality of life (Fuchs et al., 2012). This highly prevalent co-occurrence of chronic health conditions among older individuals leads not only to the need for preventive efforts, but a the same time to a higher need for healthcare support, which can be, at least partly, undertaken by the health-enabling technology equipment. Haux (2006) argued that with the availability of health-enabling information technologies and the perspective of having adequate transinstitutional health information systems architectures, a substantial improvement can be made to a better patient-centered care, with possibilities ranging from regional, national, to even global care. Applying approaches like AAL and ambient intelligence solutions can even transfer such specific and to the individual needs tailored care to private environments.

Such a development has the potential to contribute to an efficient and affordable healthcare and would support older and impaired persons to persevere an independent life. However, in view of all the current technological innovation little is known about the willingness to use such assistive technology in the relation to varying degrees of severity of disease by the parties concerned. In this context, many ethical and practical questions arise which refer not only to the degree to which diseased persons wish to use such technologies, but also to their emotional feelings connected with their health condition and the associated consequences. Also important are aspects, like how should the patient's care be structured and who may decide on therapy and rehabilitation measures. In the following, research questions of the present study are described in more detail, attempting to empirically elucidate these aspects, using a representative sample of the German population.

2.3 Research Questions

Given the current demographic situation and the expected bottlenecks for the healthcare sector, on the one side, and taking advantage of the sophisticated health-supporting technologies, on the other, this study focuses on questions referring to the individuals' perceptions and acceptance of such innovations in their lives and closer environments through the prism of a serious illness.

In concrete terms, it is unclear how persons emo-

tionally sense when they are ill, which is probably significantly associated with the given situations, states of the disease, and not least people's personalities. It is worthwhile to examine whether certain profiles can be assigned to certain disease-related situations, and thus permit to develop meaningful strategies. Moreover, it is highly interesting to what extent such sensations affect the decisions about the use of health-supporting technologies. In this study, we therefore ask (RQ1): *Do emotional and ethical sensations accompanying ill persons differ in dependency of the severity of the disease?*

In this context, it is furthermore of interest how the emotional state correlates with, or even significantly affects, the motivation to be supported in case of illness. In terms of this study, we ask (RQ2): *Does the intention to use medical technology significantly vary depending on the severity of the disease?*

Moreover, in case of (severe) illnesses, people frequently get in situations, which require decisions regarding their further/future treatment. In this context, this study examines also (RQ3): *To what extent other important stakeholders (doctors, family members) are allowed to make decisions about therapeutic and rehabilitation measures associated with the disease?*

Not least decisions about the use of health-supporting technologies or applications are important and in this context it is of interest, to what extent do people affected by (severe) diseases allow technology to support them in their convalescence? More specifically, the question arises as to the extent to which the use of health-supporting technologies may compliment, (partially) take over the job, or even replace caregivers. We therefore also examine in this study (RQ4): *To what extent do ill people allow the use of medical technology next to the support of the human caregiver(s)?*

3 METHOD

In this section, the methodological approach, the operationalization of the questions described are presented, and the study's sample is introduced.

3.1 Quantitative Data Collection

This study used an online-survey as method for the data collection and was structured as follows: At the beginning, participants were asked for their socio-demographic information regarding age, gender, professional background, self-confidence in dealing with technology (Beier, 1999) as well as general state of health, subjective vitality (Ryan and Frederick, 1997),

and the general health condition coupled with the presence or absence of chronic disease(s). In this part of the survey, respondents also indicated their experience with health-supporting devices in their daily lives.

Further, the survey focused on perceptions of criteria related to aging, like a high quality of life in old age (e.g., self-supply in daily life, competent medical care, consistent social network, etc.) as well as aspects referring to positive and negative effects of aging [for details see Wilkowska et al. (2019)]. Another part of the survey evaluated general attitudes towards the use of medical technology (e.g., "I can imagine the use of medical technology.") as well as the participants' (intended) use and assessments of health-supporting technologies in the form of benefits and barriers. Participants expressed their (dis-)agreement to the respective items on a 6-point Likert-scale ranging from 1 ("I do not agree at all") to 6 ("I fully agree").

The last part of the questionnaire represents the central content of this paper. Here, three different scenarios were introduced, varying the severity of a disease. The intention was to make the participants to envision and, as far as possible, empathize with the ill persons in the situations presented in the scenarios (S I-III). In the following, the scenarios are presented in their respective wordings:

Scenario I: *"After a serious car accident, you are hospitalized. You have suffered various bone fractures and your stay at the hospital will probably last about 2 weeks. Afterwards, you have to expect many weeks of healing (including a splint on your leg). This situation implies also other consequences which means that you are professionally absent for a few months and need some nursing support at home (at least for the time when you are bedridden and wear plaster splints). However, according to doctors, a complete recovery can be expected in the long term."*

Scenario II: *"After two heart attacks, you now suffer from chronic heart failure in stage three. This means that even slight physical exertion can cause you to become exhausted, suffer from arrhythmias or breathlessness. According to this, you need an intensive (nursing) care and a lot of support in your everyday life. In addition, you need to visit a doctor and undergo rehabilitation measures on a regular basis. The insurance experts classify you as no longer fit for work due to your state of health and they force you to take early retirement. The therapy of the disease is possible to a certain extent, but it is also very complex (i.e., drug therapy, rhythmological therapy with pacemaker devices, targeted body training, appropriate diet, etc.). By treating the causes and thanks to*

the complex treatment measures, the prognosis is improved, but unfortunately a high mortality rate is a sad reality."

Scenario III:"*Please put yourself in the difficult situation in which you suffer from colorectal carcinoma and your body is very severely impaired and weakened as a result of a chemotherapy and the following radiation therapy. You can manage your everyday life only with the intensive support of a trained nursing staff. You need support in terms of personal hygiene and daily meals as well as regarding your mobility needs. In this respect, you will be supported by both professional carers and your family members. The chances of recovery through surgery and chemotherapy depend decisively on the stage and course of the disease (on average the five-year survival rate is 40-60%). Unfortunately, the near future is uncertain.*"

The order of the scenarios was randomized. After each scenario, participants worked through four question blocks, referring to topics that are relevant for a disease and the associated consequences. The first referred to the question who, and to what extent, may have a say in decisions regarding a further medical treatment. The possible stakeholders were 'myself', 'the doctor' and the 'nuclear family', and the possible answer alternatives were 'not at all' (0%), 'a little' (25%), 'partly' (50%), 'for the most part' (75%), 'entirely' (100%). The second block of questions used the psychological method of the semantic differential (Osgood et al., 1957), in which respondents' judgments had to be placed on a 10-step scale between two poles of a dimension described by a pair of two adjectives (e.g., threatening—conforming, hopeless—hopeful, vulnerable—protected). With these, the state of people's emotional sensations and ethical perceptions was examined after each scenario. The third group of questions referred to the intention to use health-supporting medical equipment. We used the three following items: "In the context of the scenario, ...

- ...I can imagine the use of medical supportive technology."

- ...I consider the use of medical technology useful."

- ...I do not want to use medical technology at all."

The respondents could express their (dis-)agreement regarding these statements on a 6-point Likert-scale. After re-coding of the negatively poled item, scales for the intention to use the medical assistive technology were built and reached sufficient internal validities (S I: α=.78, S II: α=.80, S III: α=.81); the participants could reach in this regard 3 (=low intention) to 18 points (=high intention). In the fourth block of

questions, the survey collected the participants' opinions about which caring/nursing model they would ideally prefer with regard to the particular scenario. Four alternatives were presented, and the respondents had to choose the most preferred one: i. only nursing persons/caring staff (100% human), ii. for the most part nursing staff and partly intelligent technology (70% human and 30% medical technology), iii. half intelligent technology and half nursing staff (50% medical technology and 50% human), and iv. entirely intelligent technology (100% medical technology).

Eventually, two last questions were asked to the survey participant: "If you had the choice to decide: may technology prolong life?" and "... may technology delay dying?" In this case, only yes/no-answers were possible.

3.2 Research Approach

The empirical study aimed at an investigation of opinions regarding the support of individuals with frail health conditions by medical technology (e.g., monitoring technologies). For this purpose, respondents assessed aspects related to decisions about handling of situations of (severe) diseases and the associated consequences in an online-survey.

Using a scenario-based method, participants were introduced to three different situations referring to varying severity of a medical condition. After each scenario, which is treated in this study as an independent variable, data on the following aspects, i.e., dependent variables, were collected:

- Ethical, emotional, and social sensations,

- Intention to use health-supporting technologies,

- Permission for others to participate in the decisions on the future medical treatment,

- Desired proportion of the support from humans (i.e., caregivers) vs. health-supporting technology.

This study intended to provide an overview of the above aspects depending on the severity of a disease and the associated consequences (three scenarios as described in Section 3.1), taking the German population as an example. Figure 1 shows the schematic outline of the examined variables.

3.3 Description of the Sample

A total of N=585 respondents completed the online survey and were taken into consideration for statistical analyses in this study. A possibly broadest spectrum of the German population was addressed, including differently aged male and female individuals,
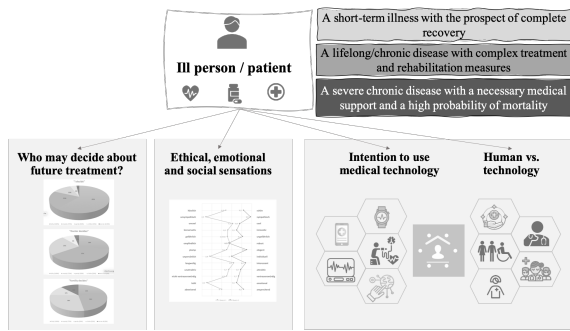
Figure 1: Research Design of the Study.

with different professional backgrounds, life experiences, and socio-economic statuses. The sample covered different professions, including individuals from engineering and IT-sectors, education and economy as well as health professionals and employers from the social sector.

The participants were German adults, ranging in age between 16 and 84 years (M=47.2; SD=16.6) and the sample was quite balanced with 48% female and 52% male respondents. As the highest educational levels, 21.5% of the participants reported to hold an academic degree and 35.7% completed an apprenticeship. A further 19.1% of the sample stated to hold a university entrance diploma, and 23.6% reported a secondary school certificate as an educational graduation. The resulting know-how connected to the technology use and the general level of self-confidence in this regard was for this sample quite high (M=18.2; SD=4.4, from a maximum of 25 points).

Since health played a central role in the study, additional information regarding health status and experience with the use of health-supporting technical equipment was also asked for in the questionnaire. More than one third of the sample (35.7%) reported to be in very good health and further 18.8% stated to suffer from a chronic condition, but to manage it very well in the everyday life. Another considerable part of the participants (41.9%) indicated to be somewhat limited due to a chronic illness and 3.6% reported to be dependent on the support of others (relatives / nursing care professionals). Moreover, less than half of the sample (44.3%) reported experience with health-supporting devices, like heart rate monitors, blood pressure meters, activity monitors, or blood sugar meters.

Participants were recruited for this study through a professional survey panel platform, which enabled to gather a representative sample of the German society. They were paid for the participation by the survey panel's institute. The composition and the characteristics of the sample are described further below.

4 RESULTS

For the statistical analyses of perceptions referring to an accepted use of health-supporting technologies in case of (severe) illness, repeated measures analyses of variance (rmANOVA) were applied in order to compare three different scenarios. As non-parametric alternative the Friedman Test was used. For effect size measures, the parameter partial eta squared (η^2) is reported according to (Cohen, 1988) and the significance value in the multivariate tests was taken from Wilks' Lambda. If the assumption of sphericity was violated (Mauchly's Test < 0.05), Greenhouse-Geisser correction was used. In the following, means (M) and standard deviations (SD) are reported for descriptive analyses and the level of statistical significance (p) is set at the conventional level of 5%.

4.1 Emotional State of the Persons Concerned

After each scenario, participants were asked to possibly realistically envision the outlined situation and to rank their emotional states on scales, lying between two adjectives that refer to particular dimensions. Figure 2 depicts the resulting means for the three scenarios.
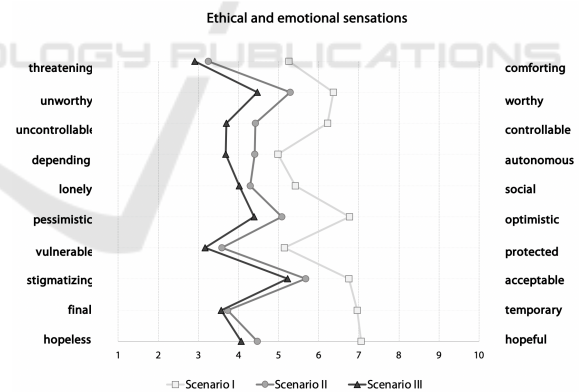

Figure 2: Ethical and Emotional Sensations for the Three Illness-Scenarios (S I-III).

Evidently, the sensations significantly differed depending on the scenario and this result is also reflected in the statistical calculations. Only the polarity profile of scenario I showed in part positive judgements: Those affected felt in such a situation worthy, optimistic, and hopeful, they were able to accept the disease to some extent, and regarded it as temporary. As opposed to this, in the situation of scenario III, participants felt threatened and vulnerable, and felt a certain finality of their state. Repeated measures analyses of

variance with a Greenhouse-Geisser correction determined statistically significant differences between all adjective pairs between the three degrees of severity of a disease. The relevant statistical parameters depicting this effect are summarized in Table 1, providing evidence that the emotional and ethical sensations sharply worsen the more severe the disease.

4.2 Intention to Use Medical Technology

Given the different emotional states, it can be assumed that these are associated with the willingness to use medical supportive technologies. In this section, it is therefore interesting (1) whether this willingness changes significantly depending on the severity of the disease, and (2) to what extent this willingness significantly correlates with the frames of mind in each scenario.

A rmANOVA comparing the intention to use health-supporting technology in dependency of the severity of the disease revealed statistically significant differences $(F(1.9,1005.8)=7.3, p \leqslant .001, \eta^2 = .01)$. Even though, according to the effect size the differences were small, the intention to use assistive technologies diminished the more severe was the illness. Figure 3 depicts these differences.
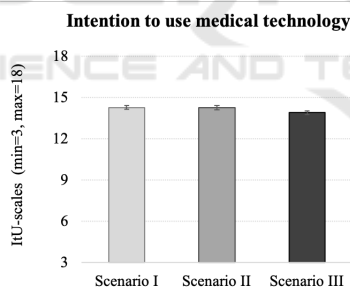

Figure 3: Intention to Use Health-Supporting Technology Depending on the Severity of an Illness.

In the next step, correlative relationships to the previously collected emotional and ethical concerns were analysed, relating these to the respective scales for intention to use assistive technology in each scenario. The resulting coefficients are summarized in Table 2. For statistical purposes, the adjective pairs were coded in such a way that the "negative" expressions show low numbers (adjectives on the left side, e.g., lonely = 1) and the "positive" expressions show high values of the scale (adjectives on the right side, e.g., social = 10).

The resulting coefficients generally display rather weak correlations. It is striking that the associations are almost consistently significant in the sce-

nario with the most optimistic healing prospects (S I). The mostly positive directions of the values suggest that an affirmative attitude to the current state of health goes along with a higher acceptance of the use of health-supporting technology. Especially, the confidence about the temporary and not stigmatizing character of the health status as well as the hopeful expectation of healing indicate stronger correlative relations with the intention to use technological support.

Moreover, the clarity of correlative relationships decreases in disease scenarios with more severe states of health and less positive prospects for the future (S II, S III). There, statistically significant associations are less pronounced, but the alignment of the resulting coefficients is the same in both scenarios. The results indicate that there is less willingness to use the assistive technology equipment, the more threatening and depending people perceive their health status. In contrast, the more they accept their situation and have a hopeful and socially oriented attitude, the more the tendency for an open-minded use of technological support for their health.

Summing up, the results show that the emotional state of the persons concerned is significantly correlated to the intention to use health-supporting technology.

4.3 Who Is Allowed to Decide?

Closely linked to these considerations is also the question of who can have a say in the various therapeutic measures and thus in the shared use of information technology for health purposes in the event of a more or less serious illness. In the questionnaire, we therefore asked the participants to quote the extent to which they would allow – besides themselves – people, like the doctor in charge and family members, to have a say in decisions regarding their further treatment (again depending on the severity of the disease in the three scenarios). In order to ease the visibility and comprehensibility of the results, only the results of the answers relating to 100% decisions ("may fully decide") are presented below (Figure 4).

Interestingly, the resulting percentages did not differ considerably in the scenarios. This finding leads to the conclusion that independently from the severity of the disease individuals mostly wish to decide about their medical treatment by themselves. With regard to the 'other people' who might have a say in the matter of the therapeutic treatment in case of illness, the preferences are distributed between the treating physicians and family members, although the proportion is slightly higher for the physicians.

Thus, according to the results, in case of ill-

Table 1: Effect of the Severity of a Disease on Emotional and Ethical Sensations in Persons Concerned.

Pairs of adjectives	Within-Subjects Effects	Means (SD)		
		Scenario I	Scenario II	Scenario III
threatening vs. comforting	$F(1.8,969.3)=275.7, p \leqslant .001, \eta^2 = .34$	5.3 (2.4)	3.2 (2.4)	2.9 (2.6)
unworthy vs. worthy	$F(1.9,982.8)=156.5, p \leqslant .001, \eta^2 = .14$	5.0 (2.3)	4.3 (2.2)	3.6 (2.2)
uncontrol. vs. controllable	$F(1.9,1032.8)=223.3, p \leqslant .001, \eta^2 = .29$	6.2 (2.4)	4.4 (2.5)	3.7 (2.7)
depending vs. autonomous	$F(1.9,999.8)=84.1, p \leqslant .001, \eta^2 = .14$	5.0 (2.2)	4.3 (2.2)	3.6 (2.2)
lonely vs. social	$F(1.9,1054.7)=105.8, p \leqslant .001, \eta^2 = .16$	5.4 (2.3)	4.3 (2.3)	4.0 (2.4)
pessimistic vs. optimistic	$F(1.9,882.7)=215.9, p \leqslant .001, \eta^2 = .31$	6.8 (2.3)	5.0 (2.3)	4.4 (2.3)
vulnerable vs. protected	$F(1.8,983.6)=197, p \leqslant .001, \eta^2 = .27$	5.2 (2.3)	3.6 (2.4)	3.2 (2.5)
stigmatizing vs. acceptable	$F(1.9,947.7)=123.2, p \leqslant .001, \eta^2 = .20$	6.8 (2.0)	5.6 (2.1)	5.2 (2.2)
final vs. temporary	$F(1.7,927.3)=396.4, p \leqslant .001, \eta^2 = .42$	6.9 (2.4)	3.7 (2.2)	3.6 (2.4)
hopeless vs. hopeful	$F(1.8,991.1)=339.5, p \leqslant .001, \eta^2 = .38$	7.0 (2.3)	4.5 (2.5)	4.0 (2.5)

Table 2: Pearson's Correlation Coefficients between the Intention to Use (ItU) Health-Supportive Technologies and the Emotional States Based on Pairs of Adjectives in the Three Scenarios (Significant Values Are Bold; Level of Significance: $*p \leqslant .05$, $**p \leqslant .01$).

| Pairs of adjectives	ItU		
	Scenario I	Scenario II	Scenario III
threatening vs. comforting	$r = .04$	$r = -.17**$	$r = -.16**$
unworthy vs. worthy	$r = .18**$	$r = .09*$	$r < .01$
uncontrolable vs. controllable	$r = .18**$	$r = .08$	$r = -.08$
depending vs. autonomous	$r = -.11**$	$r = -.10*$	$r = -.17**$
lonely vs. social	$r = .12**$	$r = .13**$	$r = .10*$
pessimistic vs. optimistic	$r = .18**$	$r = .04$	$r = .02$
vulnerable vs. protected	$r = .09*$	$r = -.02$	$r = -.08$
stigmatizing vs. acceptable	$r = .21**$	$r = .16**$	$r = .12**$
final vs. temporary	$r = .30**$	$r = -.06$	$r = .01$
hopeless vs. hopeful	$r = .38**$	$r = .13**$	$r = .11**$
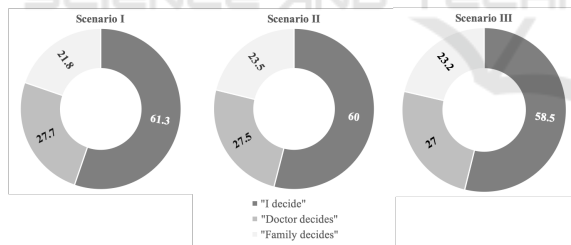
Figure 4: Percentage Rates Presenting Decisions about Who May Fully Decide about the Further Therapeutic Treatment Depending on the Severity of the Disease.

ness people predominantly wanted to decide by themselves, even when their state of illness was very severe.

4.4 Human vs. Technology in the Nursing Care?

Finally, one of the research questions referred to the extent to which ill people would allow the use of medical technology next to the support of human caregiver(s).

To examine this question, after each scenario respondents had to choose one preferred caring model among the following four alternatives: i. 100% human care (coded as 1), ii. mainly professional human carers (70%) and partly medical assistive technology (30%; coded as 2), iii. partly assistive technology (50%) and partly human care (50%; coded as 3) and iv. 100% technology (coded as 4). In order to determine statistically significant differences between the preference models, Friedman test was applied. Results of this non-parametric measure suggest that there are significant differences in the preferences of the nursing care models depending on the severity of the disease ($\chi^2(2)=7.6$, $p=.022$, $n=543$). Figure 5 summarizes the preferences for all caring models, depicting the three scenarios which refer to the severity of the disease. It can be seen that the participants mostly preferred the mixed models (ii. and iii.), where in case of illness a combined support of human and technology is offered. The percentage rates resulting for the three scenarios do not vary significantly within the different caring models. Overall, the highest percentage rates resulted for the caring model, where technology (50%) and human support (50%) are balanced (iii.). It is noteworthy, however, that per-

sons suffering from a serious illness, like the colorectal cancer in our example (S III), rather prefer the alternative of "mainly human (70%) and partly technology care (30%)" (ii.), while this caring model in the less fatal health conditions (S I, S II) was slightly less preferred. On the contrary, the alternatives of '100% human care' (i.) and '100% technology' (iv.) were chosen only by small proportions of the sample.
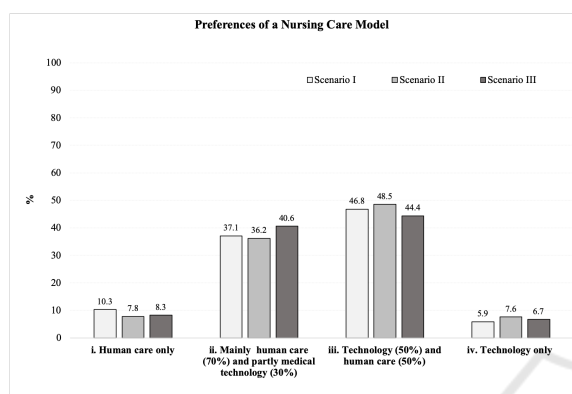

Figure 5: Percentage Rates in Preferences of Nursing Care Models Depending on the Severity of the Disease.

These outcomes let conclude that regardless of the severity of the disease the preferred models of care allow for both human carers and technology to take care for, and support, their health.

5 DISCUSSION

Aging in place in a familiar environment and as close as possible to the own family is one of the most aspired ways of life for seniors. However, with increasing age people are often tormented by (multiple) illnesses, which thwart these plans or make this wish even impossible due to the needs of care and support for their everyday lives. Today's technology development has great potential in the area of healthcare, to support people who need clear therapy for the convalescence process or rehabilitation measures, and also for those who need just some support in mastering of their everyday tasks. This can happen, at least partly, in their own home environments, using the merits of the ambient technologies or systems, sensor-based networks for activity monitoring, fall detection, and various other health-supporting applications.

But how do the elderly "tick"? A lot of research has been done to develop, evaluate, and optimize current technical applications, but relatively little is known about what the potential users – in this case the elderly, impaired, and chronically ill ones – want, how they feel about their particular state of health, and

what they are willing to allow regarding these technical solutions in their individual situations. There are some facts which one must not lose sight of: First, the today's old people are mostly technologically socialized in different matter (Sackmann and Winkler, 2013) than the so-called generation X or Y, and they have completely different relations to the use of technologies. Second, in an acute state of illness, the priorities lie in the recovery and may be completely different from those in a normal or stable state of health: It is thus quite conceivable that in such a state one no longer has the capacity to use, or learn to use, technologies even when these are very supportive. Third, according to studies (e.g., Loft et al., 2019) and from the psychological point of view, human contact is of the utmost importance for recovery and mental stability, especially for the elderly, who are often socially isolated or neglected. It may therefore be the case that diseased persons turn generally more to people than to technology.

5.1 Perceptions of the Diseased Persons

The presented study examined such considerations and can answer the research questions asked at the beginning on the basis of empirical data. Findings revealed that the emotional and ethical sensations sharply worsen, the more severe is the disease. Even if this result is not particularly surprising in itself, in the context studied here this is an important insight.

As opposed to health conditions which have prospects of a secure recovery, seriously ill people feel threatened, vulnerable, and dependent. These individuals experience a certain sense of finality and uncontrolled state of their health, and they find it difficult to show a hopeful attitude. In addition, the emotional states have been shown to be essentially related to the willingness of using health-enabling technologies. Statistical calculations provided evidence that the intention to use the health-assisting technology diminishes with the severity of the disease; even though the here provided effect was not very strong. Correlating the intention to use the health-enabling equipment with the emotional states of persons suffering from differently severe diseases suggests that an affirmative attitude due to an optimistic health prospects goes along with a higher technology acceptance. On the other side, there is also less willingness to use the assistive technology, the more threatening and dependent individuals perceive their health situation.

Therefore, in order to actually make use of the support offered by medical technology at this point in people's lives, a special sure instinct is needed. Because no one can expect that seriously ill people

leave the decision about the necessary treatment in the hands of others (e.g., medical professionals). On the contrary, the current study showed that regardless of the severity of the disease people want to decide primarily by themselves about measures regarding their therapy and/or rehabilitation. Although they grant doctors – in particular – but also family members a say in decisions about their health, according to the above findings they want to keep the final word, even if they are terminally ill.

In addition, there were only few of those who prefer a nursing care based only on the technology or coming only from the human. The majority of respondents preferred models combining the sensitivity of a human carer and the efficiency of the smart assistive technologies. In this regard, individuals with rather positive chances for recovery tend to permit more support from the technology side (50%), whereas the seriously ill persons would rather choose the care alternative with a higher proportion of human care (70%) and less proportion of technology care (30%). In any case, it seems to be an unanimous opinion that the use of health-related technology should always be a free choice of the persons concerned. This result corroborates previous findings (e.g., Hofstede et al., 2014) and shows that there is a fine line in decisions between human ('deus') vs. machine in disease situations and this quite complex process cannot be unambiguously determined beforehand.

Returning to the research questions formulated at the beginning, the following findings can be summarized on the basis of the presented results:

- Emotional and ethical sensations accompanying ill persons significantly differ depending on the severity of a disease and are significantly related to the intention to use assistive technology for health purposes. The intention itself differs slightly between the scenarios, decreasing with the increasing severity of an illness.

- Other persons, considered important in the course of a disease (e.g., doctors, family members), are allowed to support decisions about the associated therapeutic and rehabilitation measures. Yet, a majority of respondents wishes to make such decisions by themselves, regardless of the severity of their illness.

- Ill people allow the use of medical technology, but they would rarely rely only on the technology as caregiver/support in case of severe diseases. Much more, the more severe is the health status of the person concerned the more mixed caring models are desired with the tendency to prefer more nursing care from professional staff (70%) than from technology (30%).

On a final note, it is valuable to take a closer look at one of the last questions of the survey, asking if technology is allowed to prolong life. Almost 76% of the participants responded with "yes", but still one out of four persons (24%) does not allow technology to extend his or her greatest good. At this point, it is not clear – yet of great interest – who are the persons which decide against the support brought by technical innovations, but the result itself represents an important ethical question, which cannot be disregarded in the context of using assistive technology to deliver healthcare.

5.2 Limitations and Directions for Future Research

Especially the last described result makes the importance of further, deepening research in this area particularly plausible. In addition, there are still some limitations of the present research to be addressed in future studies.

In the first place, it should not be disregarded that this study only depicts the perceptions and opinions of people who have envisioned particular health states on the basis of disease scenarios, and are not based on real experiences of ill persons with acutely or in the past experienced disease states. This can lead to considerable distortions and should thus be validated in the future to get even more informative results.

Another limitation applies to the fact that the presented results are very general. Yet, the interesting questions are hidden in the particular participants' characteristics, which are considered important for the issues presented, like age groups, different levels of technical confidence, and preparedness to use technology solutions for health matters. Further studies should thus focus more on these aspects.

In addition, to enrich understanding of people's assessments and their intended use of health-supporting equipment in case of illness, examinations of their personality as well as compliance would presumably add value to the current research. Insights in this regard could enable to evolve appropriate strategies to the therapy and rehabilitation measurements for people with different illness and personality profiles.

Overall, this study gives first insights into the relevant topic of the perspective of ill persons for whom the use of assistive health-related technologies represents an important alternative enabling to live an autonomous life. Further studies are necessary from the perspective of those affected to deepen this knowledge and to apply it in the practice in an optimized way.

6 CONCLUSIONS

User perceptions of, and their willingness to use, electronic health-related technology are important determinants of its successful implementation. The knowledge about how to provide an accepted technology-enhanced assistance is, however, multifaceted and requires especially the perspective of persons concerned. This study highlights several aspects that represent the perspective of the diseased and provides valuable hints on preferred models of nursing care.

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