

Gender Differences in Acceptance and Attitudes towards an Invasive Medical Stent

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Abstract

In this research we investigate the role of gender for the acceptance of an invasive medical stent, assessing the expected benefits of using this medical technology as well as estimating potential barriers. 100 respondents of a wide age range (19-75 years) volunteered to take part in a survey. Respondents were asked to imagine the prospective need and usage of an invasive medical stent (scenario technique) and to evaluate both, the usage motives as well as potential barriers towards the usage of invasive medical assistive technologies. In order to understand the complex nature of acceptance of invasive medical technology, personal variables (especially gender, but also age and health status) and respondents' general attitude towards technology (self-reported technical interest, literacy, handling competence and distrust in technology) were related to acceptance ratings. Outcomes show that gender is a decisive factor for the acceptance of the invasive medical stent. Women tended to weigh perceived usage barriers as more crucial for technology's acceptability than the expected benefits. Also it was found that (female) participants' concerns are based on a lot of misconceptions and false information about invasive medical technology.

Overall, it was revealed that acceptance issues should be seriously considered in order to proactively design a successful rollout of medical technologies and to apply a sensitive, objective and transparent information and communication concept.

Keywords: Gender; Smart Health; Technology Acceptance; Usage Motives; Acceptance Barriers

1 Introduction

Electronic health technologies will play an increasingly important role in the coming years, as more and more older people will require medical care and support [1, 2]. Due to the prevalent demographic change and the continuously decreasing number of nursing staff and caregivers, there is an increased need for intelligent medical technologies, which enable people to live independently at home [3-6]. Electronic healthcare technologies support the interaction between patients and health service providers, institution-to-institution transmission of data, and peer-to-peer communication between patients and health professionals [7-10]. These technologies promise to deliver significant improvements in access to care, quality of care, and the efficiency and productivity of the health sector [11]. In order to reach a high degree of user acceptance, not only the technical and engineering part is of importance, but also the human aspects of these

technologies, and the way these technologies meet the wants and needs of users regarding privacy, dignity, and their requirements for as useful perceived medical technologies [12-17].

Within the last years, a variety of new healthcare concepts for supporting and assisting users in technology-enhanced home environments emerged [18-20]. These so-called Ambient Assisted Living (AAL) applications are characterised by a combined use of information and communication technologies and health monitoring devices in the home domain. The spectrum of emerging technical applications covers a broad variety of developments, reaching from internal technologies (implants for monitoring physiological signals) over devices integrated into clothes (wearable technologies) to healthcare robots or smart home technologies, which support older people in keeping up their independent live at home

[1, 3, 4].

Nevertheless, practical experience shows that the brilliance and novelty of technical solutions does not guarantee the successful diffusion of these innovations. The success of (future) healthcare technologies depends decisively on the extent to which technical developments meet the specific needs and demands of users and their willingness to use and integrate devices into their personal spaces [21-24]. We should be aware that these technologies have fundamentally changed the nature of social, economic and communicative pathways in modern societies. Communication and information are present everywhere and at any time and overcome physical as well as mental borders. Medical (mobile) technology is increasingly incorporated in private spheres (smart homes), e.g. in walls, furniture or clothes, [25-27] or even the body (invasive medical technology). Within the public awareness, these developments may cause concerns about privacy, and loss of control [18, 21, 28, 29]. Sensitive and detailed information regarding health states and physical conditions are available everywhere and anytime. This may implicate both positive consequences (productivity, mobility and growth), but also negative and threatening effects (violations of privacy, security concerns, infrastructure constraints and distrust in smart medical applications).

So far, research on medical technology is mostly dominated by technical, medical and economic disciplines. The same applies for developments of medical products, which are predominately guided by medical necessity, technical feasibility, legal matters or economic interest. In contrast, aspects of humans' technology acceptance as well as a detailed understanding of individual usage motives and barriers are mostly disregarded, or even underestimated within technical development so far. Though medical technology - especially in the home care and rehabilitation sector - can only fully deploy its huge potential for greying societies, if acceptance issues of medical applications are adequately considered and addressed in an adequate public information and communication concept. In addition, the knowledge about the antecedents of electronic health acceptance and utilisation behaviour on the user side is restricted.

1.1 Technology Acceptance

Technology acceptance is examined for more than 25 years now. Roughly comprised, one can say that technology acceptance describes the approval, favourable reception and ongoing use of newly

introduced devices and systems. Peoples' acceptance of technology is predominating the public discourse and the scientific discussion especially in times of technological cycles, in which new technologies are penetrating into personal and working environments. In the 1980's and 1990's, alongside with the ubiquitous introduction of personal computers, there was a boom of research dealing with technology acceptance. As technology cycles are taking place within increasingly shorter intervals, technology acceptance continues to be a key research issue since that time.

The majority of approaches dealing with technology acceptance refer to the acceptance of information and communication technologies (ICT) [30-36]. Theories of technology acceptance [30, 34] consider mainly two major components: the perceived usefulness of a technical device and the perceived ease of use as key determinants of individuals' intention to use a technical system (e.g. the Technology Acceptance Model, TAM [30]). However, one of the main criticisms of these models was that external factors such as the influence of individual user variables on technology acceptance were disregarded. The most recent development within acceptance modelling represents the UTAUT model (Unified Theory of Acceptance and Usage of Technology) [34], which assumes performance expectancy, effort expectancy, social influence, and facilitating conditions as key constructs for technology usage intention and behaviour. Additionally, individual variables are assumed to mediate the impact of those constructs on usage intention and behaviour. Yet, only few studies concentrated on the diversity of users and their acceptance patterns [22, 36-38], even though it is evident from daily life experience that people may have different adoption behaviors due to individual characteristics (age, gender, culture, abilities, beliefs [40-41]). Still more important, there is only little knowledge, in which respect and to which extent the type of technology (invasive vs. non-invasive, visible vs. invisible etc.) impacts acceptance patterns [18, 37, 42]. If we want to reconstruct the impact of technology adoption as well as its consequences for persons' social lives [28, 40], a deeper understanding of technology acceptance is needed.

Another, in the here addressed context, problematic characteristic of existing technology acceptance models is that approaches exclusively focus on acceptance patterns of ICT, and that they are predominantly job-related. A direct transfer of model assumptions to the acceptance of medical technology is highly disputable, though this has not

been fully analyzed yet. Up to now, only a few existing studies investigated the special nature of acceptance regarding medical technology [3, 41, 42]. However, it is quite reasonable to assume that the acceptance of medical technology distinctly differs from acceptance-patterns of other technologies, which are widespread within our societies. First, medical devices are used not just for communication and entertainment as most ICT devices are, but for (critical) health states. Secondly, beyond its importance for patients' safety and the feeling of being safe, medical technology refers to "taboo-related" areas, which are associated with disease, and illness [13, 43, 44]. Third, medical monitoring is often perceived as breaking into persons' intimacy and privacy spheres and often provokes a feeling of being permanently controlled [13, 20, 21, 28].

Hence, the acceptance for or against using medical technology is highly complex. Acceptance seems to be torn between a lot of perceived benefits but also a serious concerns, and it is influenced by individual and situational aspects, especially when focusing on medical technologies that enter the body (as it is the case in invasive technologies, e.g. a medical stent). We therefore conceptualise acceptance as a "product" based on individual usage motivations (using motives as well as perceived barriers) and situation-specific evaluations, driven by individual needs and wants. Also it is reasonable to assume that the diversity of users is critically impacting acceptance and the degree, to which a technology is perceived as respecting feelings of intimacy and dignity as well as the degree to which a technology induces trust, respect, and safety. Yet, hardly any study addressed gender differences in the field of acceptance of invasive medical technology [21, 22]. However, especially gender seems to have a specific impact for the acceptance of body-related medical technologies:

- Lower (reported) technical expertise: Research has shown that women report lower levels of computer-related self-efficacy and a higher computer anxiety [45-48] as well as a lower perceived technical confidence when using technical devices [22, 36, 38]. As a consequence, women's more negative attitudes towards technology reduce the probability of active technology interaction and lead to a generally lower computer-expertise [45, 49-52]. The lower technology aptitude and/or affection in general could also negatively bias the acceptance of medical technologies.
- Gender-specific body-related attitudes: Studies showed that women – in contrast to men – have different standards of morality and ethics, espe-

cially in combination with expected physical pain, and in combination to attitudes towards own body and body schemata [54-56]. This also could have an influence on women's evaluation of invasive medical technologies and, in turn, could modulate acceptance.

- Gender-specific health-related cognitions: It was found that women show a different extent of health-related cognitions and a higher vulnerability to feelings of physical threat in contrast to men [58, 59]. Also, the degree of risk-taking behaviour is gendered (males tolerate higher risks than women [62, 63]). These gendered health-related cognitions could specifically impact the acceptance of incorporated medical technology.
- Social (caring) role: Finally, the acceptance of invasive medical technology is of specific interest, given the gendered nature of the nursing profession, which is associated with the traditional female role of caring and servicing of others [60].

1.2 Open Questions and Logic of Research Approach

Concluding, there is a considerable need to explore and to understand the components contributing to users' acceptance of electronic health technologies. This is of specific interest in order to find alternative health care methods – in comparison and in addition to the traditional visit to the doctor's office – which meet especially the distinctive needs of older adults, and allow them to keep up an independent living at home. However, there has been a continuing debate about the extent to which the public finds health-care technological innovation acceptable.

The aim of this exploratory approach is therefore to examine attitudes towards invasive medical technologies in order to learn which using motives militate in favour of using these technologies and which kind of using barriers are prevalent, taking gender differences as a specific focus. In order to understand the specificity of acceptance patterns, general attitudes towards technology (interest, competence, knowledge and distrust) were determined and related to the acceptance of medical technology. Beyond the quantitative assessment of the acceptance, we also assessed individual conceptions about possible body regions, which are more or less tolerated for the implementation of such an invasive technology. This refers to the fact that some body parts may be perceived as especially sensitive. Furthermore, we wanted to find out, which of the reported motives and barriers are more

decisive than others and which of both, using arguments or barriers is prominently impacting on the intention to use invasive medical technology.

Respecting the validity of the finding it is of pivotal importance, whether the acceptance towards medical technology is examined in chronically ill patients, already using invasive medical technology and depending on it, or in still healthy persons, which evaluate the acceptance of invasive medical technology in a prospective manner [21, 37, 42]. Critically, one could argue that healthy persons cannot “feel” the importance and the necessity of medical technology, as they are not truly concerned. Even if this argument cannot be dismissed, there is an enormous knowledge gap about the public discourse and potential ambivalent attitudes to new health-care technologies, in combination with individual beliefs, (social) trust in health care and technology as well as perceptions of potential benefits and risks. The understanding of individual beliefs and general attitudes are of crucial impact as the public opinion also considerably impacts on the cognitive mind setting of future users. Therefore, we selected a comparably healthy sample of a wide age range, to get a broad insight into attitudes.

Outcomes are expected to allow insights into the major public opinion drivers for and against invasive medical technology. This is not only be useful for a user-centred development of medical technologies, taking acceptance issues into account, but may also elucidate the public awareness of a diligent information politics and communication rationale in this sensitive field.

2 Methods

2.1 The Sample

The recruitment rationale was to survey prospective users of medical technology, thus basically healthy people in a wide age range, in order to explore opinions about future electronic solutions in healthcare and the intended usage behaviour of medical technology. Younger participants were either university students of various academic fields or persons being in vocational training. Other respondents were reached by advertisements in local newspapers as well as through seniors' social contacts, with a broad range of professions. The data of $N = 100$ participants aged 19-75 years volunteered to take part in the study (Figure 1).

Regarding the gender distribution, 54 respondents

were female ($M = 42.4$ years, $SD = 14.8$) and 46 male ($M = 45.6$ years, $SD = 18.8$). Male and female participants did not differ within reported health states (n.s.), the frequency of visiting the doctor per year (n.s.) and educational levels (n.s.). Regarding reported health states, significant age differences ($F(2, 94) = 3.8$; $p < .05$) were revealed as well as a marginal significant age difference regarding the frequency of visiting a doctor ($F(2, 94) = 2.7$; $p < .01$).

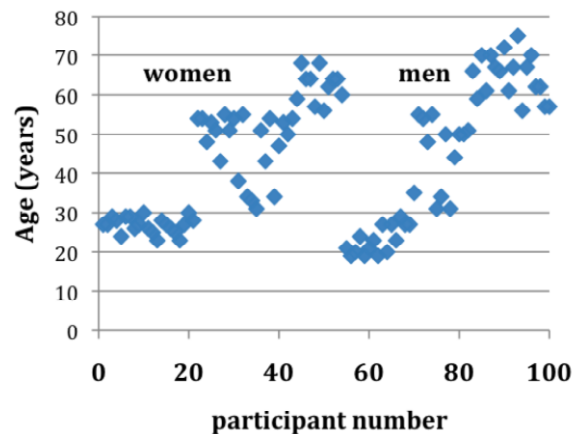


Figure 1: Number and age of participants ($N = 100$), separated for women (left scatter plot) and men (right scatter plot).

2.2 The Questionnaire-Instrument

In order to collect comprehensive opinions and to reflect them across a broader sample of women and men of different ages, we chose the questionnaire-method. Though, as the acceptance for future medical technology might be a sensitive issue, we wanted not only to gather the extent to specific questions, but were also interested to gather qualitative insights to understand individuals' attitudes and barriers. The questionnaire combined a qualitative and quantitative approach and was arranged in seven main sections. For qualitative answers, there was enough space for participants to write down personal notes or answers. In this paper, no detailed results from coded narrative text are reported. Also, we did not analyse and interpret the emphatic and sometimes emotional connotations (e.g. “I would never use it!!!!”). Instead, in a first approach, we simply counted, for example, how often specific body positions (liked vs. disliked) had been written down and also the key arguments, which participants indicated to be decisive for their overall acceptance.

- Demographic data: The first part included demographic data regarding participants' age, gender, educational level and (previous) profession.

- Attitude towards technology in general: The second section applied to respondents' attitude towards technology in general taking information and communication technologies as an example. Participants were asked to rate (a) their reported interest in technology, (b) their reported technical literacy, (c) their self-reported competence when handling technology and (d) their distrust in technology. The assessment of these generic attitudes towards technology in general allowed the correlation of outcomes to the specific acceptance items (pros and cons toward invasive medical technology). Items had to be answered on a 6-point Likert scale (very high - very low).
- Medical scenario: The third section dealt with a specific scenario. Participants were introduced to a medical scenario: "Imagine that in the year 2025 a vast majority of people in our society are 65 years and older. Many of these people will be frail and therefore reliant on medical care. Due to shortcomings in the care sector it is a basic question how older people can live independently at home, and do have access to medical services. Yet, there are already mature technical developments, which enable continuous medical care at home. One example for these developments is a so-called medical stent, an electronic miniature chip, which can be implemented at different body locations inside the body. The device is battery-free, approximately of the size of a rice grain and able to monitor bio-signals continuously and unobtrusively (e.g. blood pressure, blood quality). The device communicates vital data automatically to the doctor/medical staff and contacts the emergency ambulance if necessary."

Respondents were instructed to envisage the need and use of such a device for themselves. To minimize ambiguity and to support conceivability, there was a little figure illustrating the invasive stent (Figure 2):



Figure 2: Enlarged illustration of the stent, provided in the questionnaire. Participants were informed that the stent has about the size of a rice grain.
<http://disinfo.s3.amazonaws.com/wp-content/uploads/2010/02/Chip.jpg>

- Most preferred and most disliked body regions for the medical invasive technology. In this section participants were asked to indicate which body regions/positions they would accept as possible localization for the stent and which body regions they would dislike or even exclude. Participants were allowed to drop only one or more regions if needed and to write them down.
 - Rating of different using motives (pros) and barriers (cons) which militate in favor or against the usage of invasive medical technology. In the fifth section, participants were asked to evaluate the using motives and barriers regarding its usefulness and their willingness to use it. Items were to be confirmed or denied on a six-point Likert-Scale, ranging from "completely disagree" to "completely agree".
- The using motives – Pros – (17 items) focused on potential
- Pragmatic reasons ("reduces the duty to constantly visit the doctor")
 - Economic reasons ("if health insurances would pay for it")
 - Design reasons („unobtrusiveness of medical technology“)
 - Control reasons ("continuous feedback about my health status")
 - Necessity reasons ("if there are no alternatives")
 - Quality reasons („high quality technology“)
 - Discharge of responsibility ("relief of the fear of doing something wrong")
 - Increase in life quality ("increase in independency")
- The usage barriers – Cons– (16 items) focused on potential
- Pragmatic reasons ("reduces the duty to constantly visit the doctor")
 - Economic reasons ("high costs")
 - Control reasons ("technology controls me")
 - Privacy reasons ("others could come to know about my health status")
 - Quality reasons („technology is premature“)
 - Dependency reasons ("dependency on technology")
 - Social reasons ("fear of losing contact to the doctor")
 - Usability reasons ("error proneness")
 - Technical reasons ("distrust in technical reliability")
 - Compliance reasons ("I do not want to be continuously remembered that I am chronically ill")

Before administering the questionnaire comprehensibility and wording of items was checked for by a sample of differently aged adults (n=10).

(6) Specification of the most important using motive and barrier. In this section, participants had to indicate which of the different usage motives and barriers that have been evaluated before were most important for them. Here again, multiple answers were allowed. Additional space for comments was available in order to provide deeper insights into personal attitudes.

(7) Which is more decisive for me: the pro-using arguments or the barriers? At the end of the questionnaire, participants were requested to indicate which of both, the expected benefit by invasive medical technology (pros) or the perceived shortcoming (cons) are more decisive for their overall acceptance

2.3 Research Model and Hypotheses

In Figure 3, the research model underlying this empirical approach is outlined. Overall, we focused on gender differences regarding the acceptance of invasive medical technologies. For the quantitative approach, participants rated the extent of confirmation/rejection to the arguments, which were summed up to an overall “Pro-score” or “Con-score”, respectively. For the qualitative approach, we asked for a weighing of arguments and the indication of specific body parts, which are appropriate for the implementation of the chip. In order to learn if general attitudes toward technology are impacting medical technology acceptance we assessed four aspects (interest, literacy, competence and distrust) and related the outcomes to the acceptance findings.

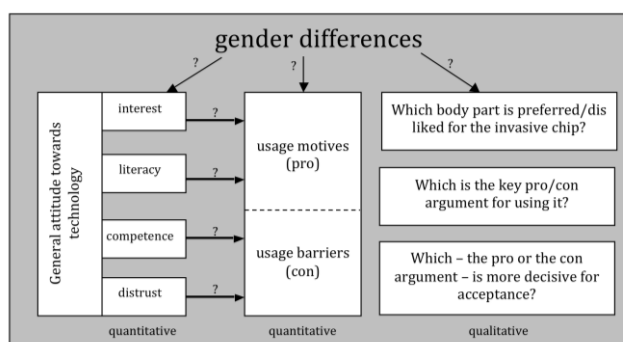


Figure 3: Research Model

Hypotheses are formulated for the quantitative data. For the qualitative sections of the survey an exploratory approach was pursued.

H1: The interest, literacy, competence is lower in female respondents than in male respondents

H2: The distrust in technology is higher in female than in male respondents

H3: Gender is affecting the pros and cons for the usage of medical technology.

H4: General attitudes towards technology are related to the acceptance of medical technology.

3 Results

Quantitative results were analysed by ANOVA-procedures and bivariate correlations to assess the interrelation between variables. The level of significance was set at 5%. For all analyses reported, we focused on differences between males and females. Interacting effects of gender and age were also reported. Qualitative data were analysed descriptively (without analysing coded narrative text, but just counting the reported arguments).

Three independent raters evaluated and classified the arguments. Inter-rater reliability was a high (>.97), and there were no non-agreed cases.

The result section is structured as follows. A first analysis regards the question, whether gender effects can be found within general attitudes towards technology (interest, literacy, competence and distrust, section 3.1). Second, qualitative findings with respect to the most preferred and disliked body parts for implementing the invasive technology are reported (section 3.2.) A third section describes the extent of approval or disapproval regarding the pro and the con arguments (section 3.3). Fourth (section 3.4), the most important arguments pro and against invasive medical technology are depicted. In section 3.5, we answer the question if respondents tend to be more strongly influenced by a con or by a pro argument for their general acceptability. A final consideration is directed to interrelations between the general attitudes toward technology and the specific usage motives pro and against invasive technology. This analysis will give insights whether a reluctant attitude towards technology in general does also imply a reluctant attitude toward invasive medical technology (section 3.6).

3.1 General Attitudes towards Technology

In this section we report outcomes regarding the general attitude towards technology (ICT). Participants had to rate their interest in technology, the technical literacy, the competence when handling technology and their distrust in technology on a six-

point scale (1: very low; 6: very high). The omnibus F-value for gender ($F(1, 84) = 9.4$; $p < 0.05$) and age ($F(2, 170) = 2.4$; $p < 0.05$) revealed significant effects. The interaction of gender x age was not significant ($F < 1$; n.s.).

3.1.1 Interest in Technology

Regarding the reported interest in technology significant gender effects were revealed ($F(1, 94) = 23.8$ $p < 0.05$). Women's interest in technology was smaller ($M = 3.5$ out of 6 points max.) than males' interest ($M = 4.7/6$ points). As no interacting effect of gender x age was prevalent we can conclude that female respondents' lower interest in technology is independently of age (Figure 4):

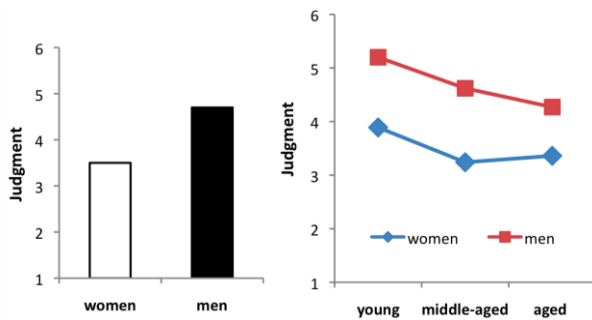


Figure 4: Left: Gender effects in the reported interest in technology (high values indicate high interest). Right: Gender effects in different ages: Young (19-30 years), middle-aged (31-54 years), aged (55-75 years).

3.1.2 Literacy with Technology

A similar picture was found for the literacy with technology. Again, women report significantly lower technical literacy ($F(1, 94) = 29.5$; $p < 0.05$). From the six points, which could be reached at most, women rated their technical literacy, with 3.5 points (in contrast to men, which rate their literacy with $M = 4.7/6$ points). Women's lower technical literacy revealed to be independently from age (no interaction of age x gender). Outcomes are visualized in Figure 5:

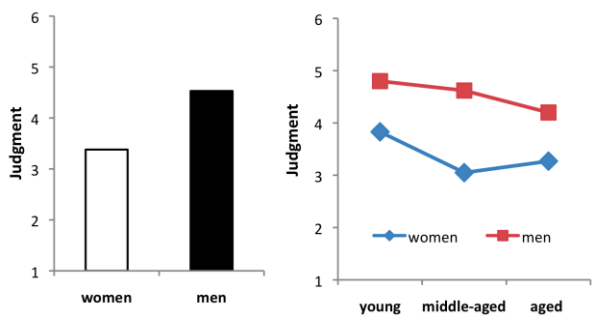


Figure 5: Left: Gender effects in the reported technical literacy (high values indicate high literacy). Right: Gender effects in different ages: Young (19-30 years), middle-aged (31-54 years), aged (55-75 years).

3.1.3 Competence when Handling Technology

Another question regarded the perceived competence when handling different types of information and communication technologies. Even for the practical handling competence, women – independently of their age – reported a significantly lower competence than did men (female: $M = 3.5/6$ points; male: $M = 4.7/6$ points ($F(1, 94) = 31.5$; $p < 0.05$). Figure 6 illustrates the outcomes:

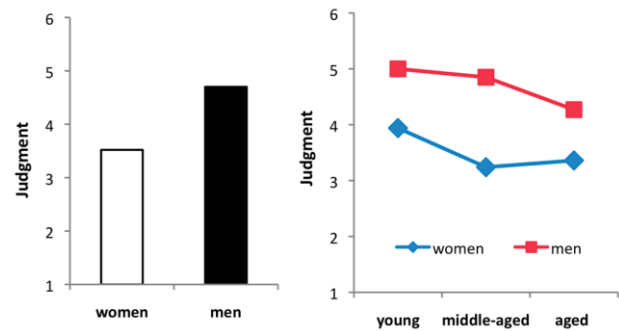


Figure 6: Left: Gender effects in the reported competence when handling technology (high values indicate high competence). Right: Gender effects in different ages: Young (19-30 years), middle-aged (31-54 years), aged (55-75 years).

3.1.4 Distrust in Technology

A final aspect in this section regards the reported distrust in technology. Beyond significant age effects (higher distrust with increasing age, $F(2, 170) = 5.6$; $p < 0.05$), gender effects were not prevalent, showing comparable extents of distrust in both gender groups ($M = 3$ (female) and $M = 3.1/6$ points (male)). This shows that general distrust towards technology is a universal attitude, which is not biased by gender (Figure 7):

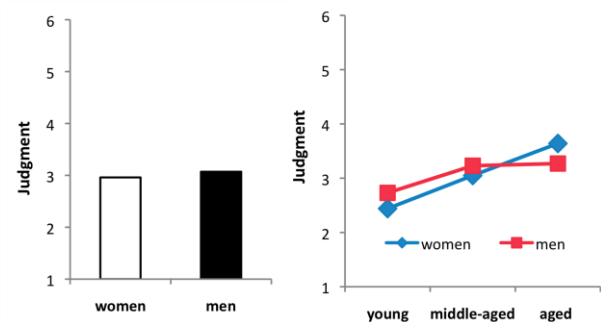


Figure 7: Left: Gender effects in distrust in technology (high values indicate high distrust). Right: Gender effects in different ages: Young (19-30 years), middle-aged (31-54 years), aged (55-75 years).

3.2 Preferred and Disliked Body Parts for Implementation of Invasive Medical Technology

Directly after participants had been introduced into the scenario, they were asked to write down, which parts of their body would be acceptable for implementing the invasive medical technology and which body regions are not seen as appropriate. In Figure 8, the “preferred” body positions are depicted (descriptively, according to frequency of being mentioned). Overall, nine different body parts were mentioned as appropriate or preferred, respectively. For the majority (53 times mentioned), the arm is acceptable with respect to an implementation of an invasive medical technology. On the second and third place (though with significantly fewer occurrence) belly and limbs were selected. Within the indications respecting preferred body positions, no gender preferences were revealed. A minority (N=5) indicated to accept each body part for the implementation of a medical stent.

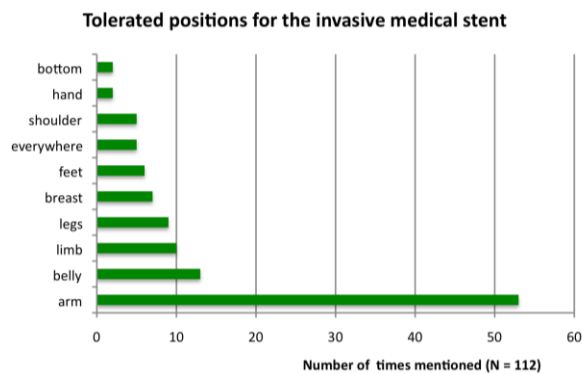


Figure 8: Preferred body positions for invasive medical technology.

The disliked body regions are visualized in Figure 9. First it becomes obvious that participants mentioned nearly twice as much disliked body parts than preferred body parts. When looking at the disliked body parts, there is one outstanding region, which is disliked most: the “head” (51 times mentioned). As categories are depicted exactly as they were literally mentioned and written down, it is at this analysing level not clear whether the “face” (11 times mentioned), the “brain” (4 times mentioned) or the “forehead” (3 times mentioned) might be synonyms for “head” or, rather, depict different facets of individual body representations.

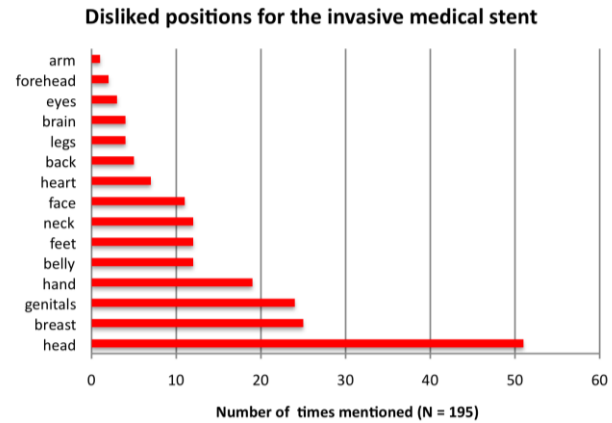


Figure 9: Disliked body positions for invasive medical technology

The second most frequent disliked body part is even a “No-Go” (as taken from the open remarks): the “breast” (predominately named by female respondents). “Sexual organs”/“genitals” were equally often named by men and women as disliked for the implementation of a medical stent (24 times mentioned). “Hands”, “feet”, “neck” and “belly” showed similar extents of disliking as body regions for implementing the medical stent (11 times mentioned). In addition, a number of participants explained in more detailed the rationale behind their choice (handwritten comments): Any body region, which is assumed to be pain-sensitive, is disliked; this applies for “bony regions” (hand, feet, shoulder) or for soft tissue body parts (belly).

3.3 Evaluation of the Usage Motives (pros) and Barriers (cons)

Now the quantitative outcomes regarding the using motives and barriers are reported. First, we formed an overall score of all usage motives (pro’s) and barriers (con’s). To this end, the ratings for the single using motives (N=17) were summed up (minimum: 17 points: very much agree; maximum: 102 points: very much disagree) as well as the ratings for the single barriers (minimum: 16 points: very much agree; maximum: 96 points: very much disagree). Gender revealed to have a significant effect on the acceptance ratings ($F(1, 98) = 4; p < 0.05$), however, age missed the significance level set. In other words this means that women perceive the benefits of the invasive medical technology as lower than men. Neither age nor the interaction of age and gender yielded significant effects (Figure 10):

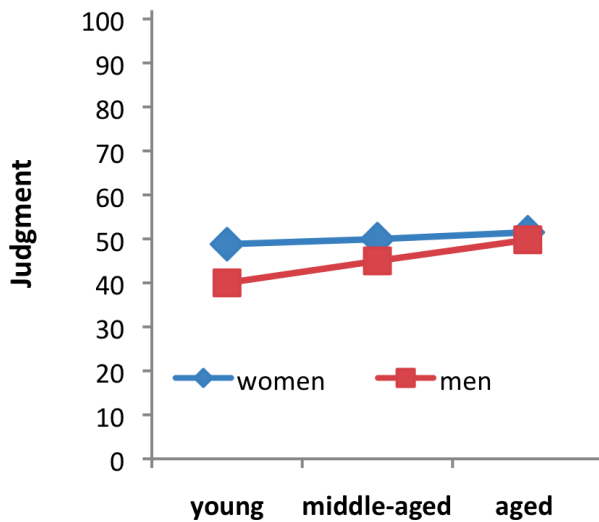


Figure 10: Ratings of pro-using arguments. Low values indicate high confirmation (more positive).

In order to illustrate items, in which the different attitudes of women and men become prominent, two examples are described. The first item “If necessary, I would use the technology without hesitating” yielded a significant effect of gender ($F(1, 55) = 3.5, p < 0.05$) as did the second item “I would use the technology, if I would get financial support” ($F(1, 55) = 5.3, p < 0.05$):

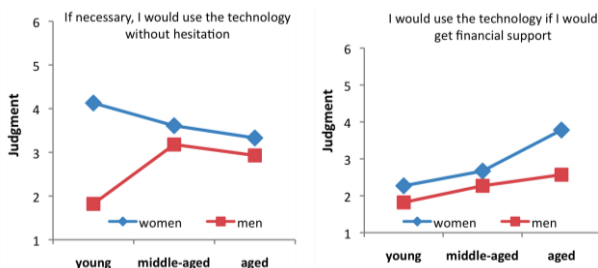


Figure 11: Ratings of women and men regarding two selected pro-using arguments. Low values indicate high confirmation (more positive).

Another significant gender effect was found for the usage barriers ($F(1, 98) = 8.3; p < 0.05$, Figure 12). Women showed a higher reluctance than men regarding invasive medical technology. Neither age revealed a significant main effect nor was there a significant age x gender interaction:

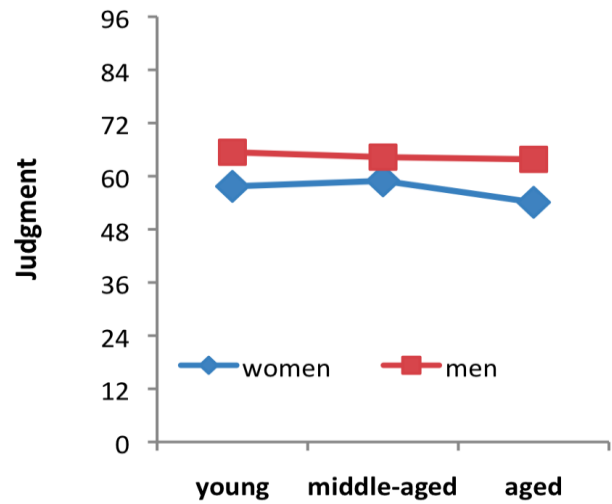


Figure 12: Ratings of using barriers. High values indicate less negative attitudes.

Also for the usage barriers, two selected con-arguments are taken to illustrate the different attitude of women and men of different ages. As can be seen from Figure 13 (left) women are significantly more concerned about potential measuring errors ($F(1,55) = 9.7; p < 0.05$) and women also fear more strongly than men that the invasive medical technology would emit noxious substances inside of the body ($F(1,55) = 3.9; p < 0.05$).



Figure 13: Ratings of women and men regarding two selected contra-using arguments. High values indicate less negative attitudes

3.4 Most Important using Motives and Barriers

After participants evaluated their degree of (dis)approval to the single using arguments and barriers, respectively, they were asked to name the most important argument militating for and against using the medical stent. Again, participants were allowed to drop more than one argument if they wanted to.

In Figure 14, the most often mentioned pros and cons (Figure 14) are illustrated. As can be seen, there are several key usage motives, which – from

the perspective of participants – militate in favor of using the stent if necessary. The first is the possibility to be continuously monitored (23 times mentioned); the second common pro-argument is the feeling of high control and supervision of health conditions (18 times mentioned).

The next arguments show that unobtrusiveness and invisibility of the medical device is a strong argument for using it (16 times mentioned) as well as the feeling of being safe (16 times mentioned). Also, independency from frequent doctor visits, the increase in personal freedom and an unworried life style are important for participants. Within the usage motives, no different gender effect was present, but women and men showed the same answering patterns:

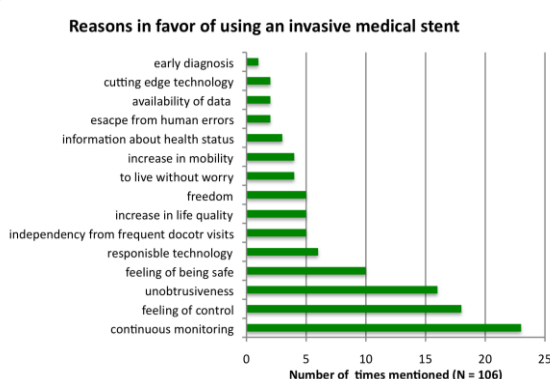


Figure 14: Most often reported main reasons in favour of using an invasive medical stent.

When looking at the usage barriers (Figure 15), we see at a first glance that -overall- participants mentioned absolutely more usage barriers than usage motives:

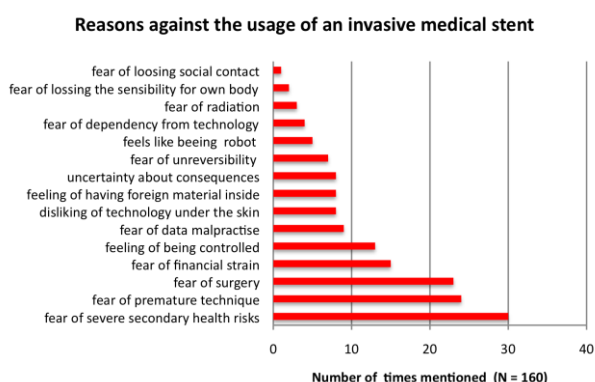


Figure 15: Most often reported main reasons against the usage of an invasive medical stent.

One could have expected that the most prominent barrier would be the unwanted control and the fear of a low data safety, as this is a highly discussed topic within German and/or European countries

regarding the use of modern technology. Though, this worry was not that prominent. The most often reported using barrier is the fear of secondary health risks (30 times mentioned). It was quite astonishing (if not alarming) how detailed and sometimes irrational the reported concerns about health risks were and what respondents associated with the use of an invasive medical chip.

Even though participants were informed about the real (miniature) size of the stent (see figure 2), they indicated to fear that its position inside the body could hurt. Participants reported to fear that the stent could implode and, as a consequence, could destroy and melt blood vessels. Also there were concerns that the chip could be leaky and that noxious substances could poison the body. Finally, participants were worried that the stent could send out signals, which could interfere with signals in the orbit and environment. Beyond secondary health risks, respondents' reported second main barrier was the fear that the technology could be premature (24 times mentioned), causing a lot of technical errors and, by this, having an overall low reliability and safety. The third most often reported using barrier was the very general fear of surgery (23 times mentioned), which would be necessary to implement the stent within the body. The burden of financial strain is another severe barrier (15 times mentioned), which was already found in the strong confirmation of the pro-item (I would use the technology if I get financial support). Further concerns regarded a general disliking of "technology under the skin" (8 times mentioned), the feeling of having foreign material inside the body (8 times mentioned), and the unspecific fear of uncertainty about consequences.

3.5 Which is more Decisive for Acceptance? The Pro-using Argument or the Perceived Barrier?

From a psychological point of view, having many pro-using arguments, which militate in favour of using a specific technology, does not prevent us from having many con arguments at the same time [21, 61]. However, the cognitive handling strategies and the coping styles differ greatly across persons [62] and individual risk behaviours [63] show considerable gender differences. Therefore, it is likely that persons also differ with respect to the question, if acceptance for the invasive medical stent might be formed by the pro-using argument (and expected benefit) or, rather, by the feared disadvantage and the con-arguments, respectively. A

final consideration thus addresses the question if women and men apply the same decision criterion which of both – the positive or negative side (main pro-using argument vs. main con-argument) is more decisive for their overall acceptance.

As can be seen from Figure 16, there is a distinct difference within the decision pattern of women and men. While the majority of the male group (71.4 %) reported to rely on the pro-argument and to a lesser extent to the con-argument (28.6%), women showed a less unequivocal behaviour. 53.3% of females tended to focus on the pro-arguments, but still 46.7% reported to rely on the contra-using argument, thereby showing that they respect the perceived barriers more strongly than the expected benefits. A deeper insight into the data shows that this female acceptance pattern is not biased by age, but a unique pattern of the female group examined here. This finding corroborates the gender-sensitiveness of risk-behaviour [63]:

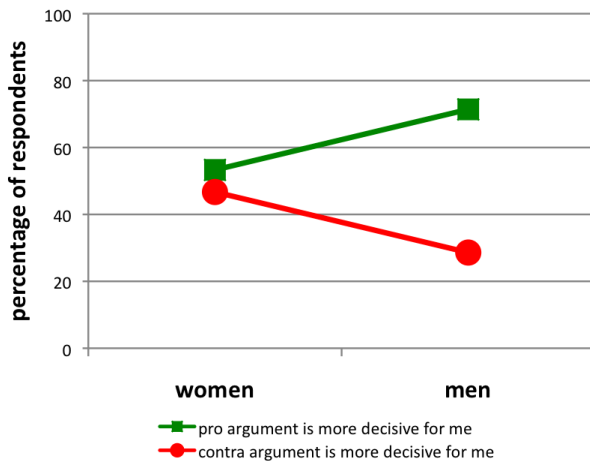


Figure 16: Gender effects respecting the question which of both the key using motive or barrier is more decisive.

3.6 Interrelations between general attitudes toward technology and the acceptance of invasive medical technology

Finally, we present interrelations between the personal variables (age, gender, health state), the general attitude towards technology, and the degree of confirmation to the pro-using arguments and the contra-using arguments of the invasive medical stent. Outcomes are presented in Figure 17.

To begin with the personal variables: Age and gender revealed to be significantly correlated to the general attitude towards technology (the aged and females show considerably lower levels). In contrast to age, which did not show significant correlations to the acceptance of medical invasive technology, there is a significant correlation of gender to the contra-using arguments ($r = .27$; $p < 0.05$): Females weighed the perceived negative characteristics and consequences of using an invasive medical stent as much more decisive, in contrast to the pro-using arguments and, also, in contrast to males. It is an interesting finding that the respondents' health states did not show a significant relation to acceptance of medical invasive technology. Apparently, the acceptance for or against the invasive medical stent represents a kind of general or categorical attitude, which seems not to be modulated by physical restraints and frailness, at least not in this sample. It is important to note that about 50% of the sample reported to suffer from one or more diseases (e.g. high blood pressure, diabetes), but not in a severe and essential extent.

Regarding the question if a positive/negative attitude towards technology in general is related to the acceptance of medical invasive technology, outcomes are unambiguously: There is a strong

	Age	Gender	Health state	Interest	Literacy	Compe- tence	Distrust	Pros	Cons
Age									
Gender	-								
Health state	-.31**	-							
Interest	.2*	.46**	-						
Literacy	-	.52**	-	.85**					
Competence	-.20*	.54**	-	.86**	.93**				
Distrust	-.33**	-	-	-	-	-			
Pro	-	-	-	-.27**	-.24**	-.25*	.22*		
Con	-	.28**	-	.48**	.44**	.48**	-.22*	-.47**	

Figure 17: Correlation matrix for individual variables and acceptance outcomes. Significance level at $p < 0.001$ are indicated with **, at the $p < 0.05$ level with *.

relation. Respondents, which report to have a low interest in technology in general (ICT) tend to strongly confirm the using barriers ($r = .48$; $p < 0.05$), and to consider the pro-using arguments for themselves to a lesser extent ($r = -.28$; $p < 0.05$). The same applies to the self-reported technical literacy, and the self-reported technical handling competence: Respondents, which report to have a small technical literacy and a low competence in handling technical devices, show not only a more reluctant approval to the perceived benefits of using the invasive medical stent (literacy: $r = -.24$; $p < 0.05$; competence: $r = -.25$; $p < 0.05$; distrust: $.22$; $p < 0.05$), but also a stronger confirmation of the contra-using arguments (literacy: $r = .44$; $p < 0.05$; competence: $.48$; $p < 0.05$).

4 Discussion

In contrast to a detailed and rich level of awareness regarding factors of technology acceptance in the information and communication sector and a job-related context, only poor knowledge is prevalent about the specificity of technology acceptance in medical technology, especially regarding invasive medical technology. This lack of knowledge is precarious, when considering the upcoming need for medical (invasive) technology in the home-care sector and the upcoming societal shortcomings regarding economic, structural and personal resources [1].

The aim of the present study was to understand the expected benefits and barriers towards the usage of a medical invasive stent (as one specific type of invasive medical technology) and to reflect the nature and kind of hopes and concerns, which determine cognitive mindsets and acceptance patterns towards this medical technology. A specific focus was directed to gender differences in this sensitive field. In order to gather detailed insights into a complex phenomenon, a combination of a quantitative and qualitative research approach was pursued. On the one hand, we quantified the extent of confirmation or disapproval to several using motives (pro and contra arguments). On the other hand, we collected qualitative insights, asked for the individual weighing of the arguments, which militate in favour and against using such an invasive stent. In order to identify to which extent the learning history with technology impacts the acceptability of medical technical assistance, respondents' self-reported literacy and handling competence with ICT and their positive (interest) vs. negative (distrust) attitudes towards technology

usage in general were assessed and related to acceptance outcomes.

Before findings of the research are discussed respecting their implications for research, application and future research demands, a first comment regards to the responsiveness of participants. People asked to participate in this research showed a prominent interest in the topic and a high willingness to participate, independently of generation, health status and gender. Also, we observed that the questioning provoked a lot of handwritten comments of participants, which wanted to make specific personal notes to the topic. Even though we did not yet deeply analyse the handwritten comments within narrative analysing techniques, but only reported the major content-related argumentation, we observed a high public awareness for the societal needs of medical technology: a far-reaching dispute about invasive medical technology in general as well as a high motivation to express own opinions and fears connected to its usage.

Generally, it can be stated that people's willingness to use medical technology – if necessary – is quite high. Also, the enormous impact of medical technology for societies and the benefit for the own person is not only acknowledged, but also highly valued. However, beyond this basically positive attitude there were lots of reported barriers, assumed drawbacks, and emotional concerns.

On a first sight the presence of emotional concerns is not surprising, as the number of barriers and concerns is inversely related to the familiarity with the technology under study. This argument is supported by the fact that a sample was examined, which was not regularly and essentially using medical technology (even though chronically ill people were included in the sample). Thus one could critically argue that the evaluation of a technology, which is not popular, naturally evokes concerns following the well-known phenomenon according to which "each generation is reimagining the dangerous impacts of technology on mind and brain. From a historical perspective, what strikes home is not the evolution of these social concerns, but their similarity from one century to the next, to the point where they arrive anew with little having changed except the label" [63, <http://www.slate.com>]. From the latter point of view, current concerns towards medical technology could be the same phenomenon that happens to any new technology and, finally, one could expect that increasing familiarity with this type of invasive medical technology will continuously shape acceptance as a matter of time.

However, some cautionary notes have to be considered in this context. Even for the arguments, which militate in favour of using the invasive medical stent, respondents distinctly stressed only conditional acceptance. They agreed to use the technology under the condition that they are urged to use medical technology without having any alternatives. (It should be mentioned that there were - even though only few - respondents that categorically rejected to use any invasive technology.) Thus, overall, invasive medical technology is not characterised by a positively connoted usage motivation, as e.g. to gain independency and mobility when being ill and frail. In contrast, the usage of an invasive medical stent is characterised by avoidance motives: illness, disease, frailness, and ageing, in combination with a feeling of helplessness and loss of control. Thus, in contrast to other technologies, whose acceptance might be impeded by their unfamiliarity in the beginning of the rollout process, medical technology suffers – in addition – from its stigmatising nature and its role as a compensating technology, which only comes into the fore when the body constitution is suboptimal, decreasing and debilitated.

When looking at the nature of the pro-arguments, it was found that the most frequently reported benefits were connected to the invasive technology itself. People argued to positively value that they are continuously monitored, that they would feel safe and have a high control over their health conditions. But they were also pro-using arguments, which were related to (design) characteristics of technology. It was positively seen that the invasive technology is unobtrusive, invisible and inconspicuous (and therefore not stigmatising) and that the technology is highly reliable (as handling errors are reduced).

In contrast, the using barriers are connected to more general fears. The most important argument against using the invasive medical stent was the fear of secondary health risks. Here it was astounding how detailed respondents pictured personal “horror” scenarios: The invasive technology, could “implode”, or “melt” blood vessels. It could have “leakages”, and noxious substances could poison the body. Also, the stent “could move or wander through the body”, and this “could hurt”, especially in “bony” body areas. Singularly, respondents feared that the invasive stent would receive other signals from other frequencies, which then could have detrimental effects on their health. Also, participants frequently insinuated an immaturity of this medical technology, leading to an overall negative bias, as its consequences are not

foreseeable. Again, it becomes obvious that reported concerns are – from a logical point of view – quite irrational, reflecting a high general insecurity and a low information level. Apparently, it is not known that any medical technology has to undergo a very high technical and medical security as well as safety standard before the technology is marketable.

Also, there was a high aloofness to the invasiveness of the technology, and a global fear of surgery, which is disliked by many respondents, independently of age and gender. Even though there are naturally surgery risks, it is from a psychological point of view quite astounding how strongly health-related concerns differ depending on the situational context. When looking at the increasing frequency of cosmetic surgery, and the – especially among women – high willingness to accept surgeries for cosmetic and beauty reasons [64, 65], it is not easy to understand why the risk of surgery is so negatively biased in the medical invasive technology sector. Similarly, it is of specific interest, why sensitive body areas as the breast and the genitals – highly disliked body regions for the implementation of an invasive medical stent – are so popular and favoured with respect to body piercing. Another example for this cognitive mismatch is the finding that medical monitoring is often perceived as breaking into persons’ intimacy and privacy spheres, accompanied by a loss of control and the feeling of being permanently controlled. This is not the case in technologies in the ICT and entertainment context, even though technology characteristics (mobile device for medical technology or a mobile phone) are the very same [21, 61, 67, 68]. Finally, one major barrier was seen in the expected financial strains, which are supposed to be connected to these new technologies.

With respect to gender differences, a prominent finding referred to a confirmation of the highly common prejudice that women have lower levels of technical interest, a lower reported literacy and handling competence, corroborating previous research. In contrast, the distrust towards technology was not gendered, but revealed similar extents of distrust in men and women.

Beyond the sadness of women’s own negative self-perception towards technology, it can be shown that this sustainable disregarding of own competence and looking small behaviour has consequences. The negative self-perception is significantly related to a low acceptance of medical technology. Persons with a more negative attitude towards technology in general, a lower self-reported technical literacy and a lower technical handling competence tend to

overestimate the perceived using barriers towards medical invasive technology and to weigh the perceived gains to a lesser extent. This shows that is not necessarily the medical technology itself, which is evaluated in the end, but a more general attitude, which is transferred from one technology type to another.

Thus, overall we can state two major findings:

- (1) Persons, especially women, show a considerable aloofness towards medical invasive technologies, and
- (2) a lot of false information is prevailing, especially respecting potential negative consequences and risks of damage.

Where does all this information come from?

To date, we do not have a specific information and communication concept for medical technologies not to mention any awareness that there is a considerable need for this. Rather, technical designers seem to believe that frail or ill persons will automatically and easily accept medical technology out of pragmatic reasons and that no detailed information about the using conditions and usage consequences is needed. It seems to be a common belief that persons must want to use medical devices in order to keep independency and mobility, and that they will use this technology anyway, as they do not have alternatives. Considering that “ageing” and “illness” entail different developmental processes, attitudes, and biographical influences, this assumption seems rather naïve, if not ignorant. People developing and designing medical technology should take respondents’ rather reluctant attitude in this regard seriously. Also, the low level of valid information and objective knowledge about consequences of using medical invasive technology was evident. It should lead to the public awareness of an urgent need of an appropriate and transparent information and communication strategy that involves users very early and specifically addresses (potential) users’ individual concerns and expected benefits.

A final note is concerned with the “value” to live longer by means of medical technology. Even though a high life expectancy and longevity is a general societal value and also an unquestionable goal out of the perspective of medical practitioners, this might though be different out of the perspective of a person, which is already old, or frail, or even chronically ill [27, 38]. In addition, we should be aware that the perceived usefulness of medical technology for an independent (longer) living of older persons might be a rather culture-dependent

view. Yet, hardly any study was concerned with the impact of different cultures and societal ageing concepts on the acceptance of medical technology, even though the understanding of the culture impact in this context might be very insightful [69].

4.1 Limitations and impact for future research

In this research, we only focussed on one type of medical technology, in a very specific scenario. Future studies will have to consider the specificity of the outcomes reported here and compare them to attitudes and utilisation motives in other medical technology contexts. This is of specific impact given the fact that the very same arguments for or against a specific medical technology may change their importance or even their weight when the using context changes. It would be interesting to explore the relation of different body-related operations (e.g. body piercing, tattooing, cosmetic surgery, and medical invasive technology) regarding acceptance patterns and underlying acceptance arguments or the role of data security concerns within different using contexts.

Current approaches of technology acceptance describe a static perspective of acceptance, whereas the acceptance of medical applications might have many dynamic components, which are influenced not alone by disease-related changes in health state, but also by different coping strategies and compliance behaviours. Therefore, future approaches should aim at the integration of health-related constructs – such as compliance behaviours and coping-styles – and dynamic components of acceptance patterns in the theoretical explanation as well as in the modelling of acceptance and utilisation behaviour with respect to medical technology.

Future studies will also have to undertake cross-cultural comparisons regarding the societal acceptance of aging, and illness and their relation to acceptance of medical technology.

Finally, a user-centred approach is needed, which (1) explores and weighs the contributing factors of medical technology acceptance, (2) considers demands of a highly heterogeneous user group and the dynamic character of ageing and diseases in health-related utilisation context, (3) identifies barriers and (4) derives practical interventions in order to promote higher acceptability of medical assistance.

5 Conclusion

In this exploratory study, gender was revealed as a decisive factor for the acceptance of invasive medical technology (taking a medical stent as an example). Female respondents tended to weigh perceived usage barriers as more crucial for technology's acceptability than the expected benefits. Also, it was found that respondents' concerns towards the usage of medical technologies are based on misconceptions and false information about invasive medical technology. In addition, the general attitude towards technology in terms of technical interest, technical literacy, the competence when handling technical devices as well as the perceived distrust in technology were found to be crucial predictor variables for the acceptance of an invasive medical stent. Overall, it was revealed that acceptance issues should be seriously considered in order to proactively design a successful rollout of medical technologies and to apply a sensitive, objective and transparent information and communication concept.

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