ECONOMIC ASPECTS AS INFLUENCING FACTORS FOR ACCEPTANCE OF REMOTE MONITORING BY HEALTHCARE PROFESSIONALS IN GERMANY

Florian Leppert Dipl-Ök, Christoph Dockweiler MSc, Nora Eggers BSc, Kerstin Webel BSc, Claudia Hornberg PhD, Wolfgang Greiner PhD

School of Public Health, Bielefeld University, Germany

Abstract
The uptake of telemedicine remains low in Germany. Barriers include a lack of willingness of adoption and user’s acceptance. Change in adoption and acceptance of new technologies is characterised by a mutually influencing network of different attitudes and behaviours which differ in severity depending on each user group. One key factor is the economic framework. Thus, we examined the influence of economic determinants influencing the attitude of physicians towards remote monitoring in Germany. Methods: Using an online survey, 201 outpatient physicians of different specialties were questioned. The participants (84.3% male, mean age 53 years) were asked to assess empirically based economic attributes regarding an implementation of remote monitoring. Results: There is a lack of information regarding the economic risks of using remote monitoring, with only 14% of the interviewed physicians feeling sufficiently informed. The barriers identified were missing reimbursement arrangements, uncertain economic advantages, and missing business models. Furthermore, the costs of implementation are not clear for the great majority of interviewees. However, users expected economic advantages from telemedicine. Conclusions: In addition to definite legal framework conditions, information security, and quality-based guidelines, a stronger focus on economic topics is required. It is clear that physicians in particular need to be better informed.

Keywords: Remote monitoring; telemonitoring; adoption; acceptance; economic influences; business environment.

Introduction
Due to demographic change in Germany, it has become increasingly difficult to ensure proper medical care for all, especially in rural areas. Chronic diseases and those requiring intensive treatment are on the rise. Telemedicine has potential for overcoming these problems because it allows medical care without direct contact between healthcare providers and patients. Yet uptake of telemedicine in Germany remains below expectations. Most implementations have been pilot projects, and only a few applications are recognised and accepted by health insurers. Even so, doctors in Germany see potential benefits from remote monitoring for outpatients. Remote monitoring (transmission of clinical parameters from a patient's home to a physician) is the most diffused telemedicine application in Germany, covering chronic diseases like COPD, cardiac insufficiency and diabetes. It involves delivery of health information (e.g., blood pressure, weight, blood sugar) from the patient’s home to the physician by information and communication technology (ICT) to monitor the patient's condition. But successful implementation of such technical solutions requires acceptance by all stakeholders involved – particularly healthcare providers – as only then can the full potential of the new system be realised.

There are three main components of a theoretical construct of acceptance. First, there is affective, cognitive and conative attitude formation (attitude acceptance); second, there is the specific level of action in the context of those adoption decisions (e.g., purchase); and third, there are subsequent object-related actions - i.e., the use (behavioural acceptance). The goal of ‘acceptance research’ is the clarification of determining aspects of both attitude formation and the resulting change in behaviour. The
scientific and concurrent practical consideration of these two levels is crucial for a needs-based development of telemedicine. First level ‘adoption’ starts with attitude formation and reaches right up to the first moment of using the technology, while the second level ‘behavioural acceptance’ of ICT is the subsequent use following a positive acceptance decision. Only against this background is it possible to operationalise the acceptance process, which is crucial for both theory-based and empirical discussion.

In this context, factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions are used for the operationalisation of acceptance as part of the “Unified Theory of Acceptance and Use of Technology” (UTAUT). The models have already been tested in different technology-assisted care settings. Moderating factors include gender, age, cultural background as well as experience, and individual technology-related competency profiles of application. Increasingly, factors such as ease of use, trust, privacy and reliability are also integrated into existing theory-based approaches.

Changes in healthcare systems often lead to acceptance problems because too little information is made available before the introduction of an innovation. But, according to Rogers, in the innovation-decision process information is an important factor in influencing the adoption or rejection of innovation.

Information serves as a motivation to seek further complementary information, and form an opinion about advantages and disadvantages. Product-specific characteristics are also a decisive factor for the decision of adoption. Furthermore, economic aspects appear to particularly influence the perception of relative advantage and risks of innovations.

A relative advantage is the perceived degree of an advantage of the innovation over an existing product. The advantage may show in the form of technical, economic, and/or social benefits. The risk of innovation is evident, however, in the degree of doubt about achieving desired objectives, requiring technical, social, and economic factors to be carefully weighed.

This paper focuses on the relevance of economic-related advantages and disadvantages in the use of remote monitoring.

Methods

The relevance of financial factors in influencing acceptance of telemedicine applications by service providers in Germany was determined using a two-step procedure. First, a systematic literature search was undertaken in two search portals: Medpilot (provided by the German National Library of Medicine (ZB MED) and the German Institute of Medical Documentation and Information (DIMDI)) and the Database search of DIMDI itself. The latter uses 30 databases including Medline. We searched for studies and articles that focused on the acceptance and or adoption by outpatient physicians in Germany of eHealth, electronic health cards, telecare, telemedicine and remote monitoring. We included studies that looked at economic aspects that could influence the adoption or acceptance (Figure 1). From the 16 relevant studies found, basic determinants of adoption and acceptance were extracted and used to develop a theoretical effect model (Figure 2). Second, these findings were used to draw up a quantitative online questionnaire.

Figure 1. Flow chart for the identification of relevant literature.
The online directory for doctors and physicians held by the German Medical Association (GMA) was used for sample selection. Since no nationwide sample was obtainable, separate searches by state and specialisation were performed and all physicians with a public e-mail address were included. A total sample of 6,000 physicians from the specialisations of general medicine, diabetology, endocrinology, cardiology, pneumology and pulmonology was obtained. During an eight week period in fall 2013, the identified physicians were contacted by e-mail and asked to participate in the online questionnaire.

The questionnaire comprised three parts. The first part consisted of questions on the level of information regarding economic aspects of remote monitoring. The second part consisted of questions about the attitude of those surveyed regarding remote monitoring applications and economic aspects. Some insight about the latter was found during the literature review and is considered a factor influencing acceptance or rejection of remote monitoring innovations.

The third part consisted of questions on general (socio-demographic) matters. The questionnaire mostly consisted of closed questions, using a four-point Likert scale – Strongly Agree, Agree, Disagree, Strongly Disagree. Partially open response categories were included so as not to unduly restrict answers. Prior to the survey, a pre-test was conducted to identify and eliminate any ambiguity and wording problems and to determine the likely duration of the survey.

The online questionnaire afforded anonymity and participation was voluntary. As the study did not involve patient or personal information or interaction with patients, according to the Ethics Committee of Bielefeld University no formal ethical approval was necessary.

Results

Deriving key determinants from the literature
The included studies showed that an expected improvement in efficiency (e.g., due to more effective use of resources, or more efficient service provision) functioned as an acceptance promoting factor. However, significant economic concerns about the implementation of telemedicine care programmes for providers were identified. For example, the fear of high cost burdens, an increased administrative burden, and poor cost-benefit ratios have a negative impact on implementation decisions. The literature indicates that physicians perceive telemedicine applications to be economic burdens rather than providing economic benefit.

From the literature review, a model was derived which included economic factors that influence acceptance, adoption or rejection of eHealth applications (Figure 2). The crucial factor leading to adoption or acceptance versus rejection of eHealth is the cost-benefit ratio, which in turn is influenced by various economic determinants. These economic aspects are often difficult for physicians to understand or quantify. Therefore, the clearer the economic aspects are for telemedicine applications, and the better the cost-benefit ratio, then the likelier it is that the decision made will be for acceptance and adoption of eHealth.

Of all factors which determine acceptance and adoption, whether positive or negative, the level of information had a major impact. The more doctors are informed and feel informed, the better their assessment will be of the various economic aspects of telemedicine applications, which can then be accepted or rejected more rationally. Based on this model, the questionnaire for the subsequent survey was derived.

Description of the Sample
A total of 201 outpatient physicians participated in the survey. Most were male (84%), and between 25 and 73 years of age (mean 53.2 years; according to GMA, 52.8 years), with the majority (45.8%) in the age group of 50-59 years, and 23% over 60 years old. Relatively few doctors aged 20-39 years took part in the survey (6.5%). Most respondents were general practitioners (78.6%). The breakdown by speciality is shown in Table 1. About half of those surveyed (53%) were solo practices, while 40.5% were practices with 2-5 physicians. Only 3.5% practiced in groups of six to ten physicians, and 3% with more than ten. New technical acquisitions (including telemedicine systems) are jointly financed in most group practices (81.9%).

Awareness and level of information on remote monitoring
Only 13.1% of respondents used remote monitoring in their professional life. However, the majority were aware of remote monitoring (72.4%). Slightly more women were aware (79.2%) than men (69.8%). The duration of clinical practice did not influence
knowledge of telemedicine, with 83.3% of those in practice for 7-9 years, and 80% of those in practice for 30-34 years expressing knowledge of remote monitoring.

Although aware of remote monitoring, only 37.1% of respondents felt informed about both remote monitoring and its benefits, and just 14% felt informed about the economic risks of remote monitoring (e.g., no amortization of invested capital). Older and more experienced physicians, those who had already worked for 25-29 years, felt uninformed (80%). While doctors under 50-years felt informed about remote monitoring, only 32.1% of those over 50-years did so. Of physicians that knew about remote monitoring, about one-half felt informed in general (49.2%), or (slightly more likely) not informed (50.8%). Of doctors aware of remote monitoring, 48% felt informed about the advantages of remote monitoring.

**Attitude to Remote Monitoring**

When asked which aspects positively influenced the decision whether or not to adopt remote monitoring, lack of reimbursement by statutory health insurance (SHI) for advice (sessions to advise / counsel patients on how to use the technology at home) was cited by 85.5% of respondents. Similar results can be seen in terms of remuneration for the use, long-term savings, and reimbursement of investment costs. Premiums

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**Table 1:** Characteristics of the study sample and the basic population.

<table>
<thead>
<tr>
<th>Study Population</th>
<th>Base Population (in thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Subjects</td>
<td>201</td>
</tr>
<tr>
<td>Characteristics</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>84.3</td>
</tr>
<tr>
<td>Specialty</td>
<td></td>
</tr>
<tr>
<td>GP</td>
<td>78.6</td>
</tr>
<tr>
<td>Cardiology</td>
<td>11.7</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>9.7</td>
</tr>
<tr>
<td>Pneumology</td>
<td>4.1</td>
</tr>
<tr>
<td>Angiology</td>
<td>2.0</td>
</tr>
<tr>
<td>Diabetology</td>
<td>6.6</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age in years</td>
<td>53.2 ± 8.3</td>
</tr>
</tbody>
</table>
play a relatively minor role in the purchase of new systems (Table 2). In the following sections the responses “strongly agree” and “agree” are combined and are considered to indicate a generally positive response, while the responses “strongly disagree” and “disagree” are combined and are considered to indicate a generally negative response.

The most frequently cited factors regarding long-term economic advantages are shown in Table 3. These were higher patient satisfaction (74.2%), increased quality of care (72.9%), improved communication (69.7%), and cross-disciplinary collaboration (69.3%). Only 31.6% associated individual health services (IGeL) with a positive business potential; while 36.8% saw doubtful benefit (disagree) and 31.6% saw no benefit at all (strongly disagree).

Factors that negatively influence adoption and implementation are shown in Table 4. Almost all of those surveyed (97.3%) acknowledged that the cost of implementation hinders the introduction and use of remote monitoring. Similarly, 96.7% cited a lack of funding agreements as a negative influence. Additional negative aspects were: unclear financing models (90.1%), non-specific financial advantage (89.5%), lack of investment funds or resources (88.7%), and reimbursement (billing) problems (84.7%). Lack of acceptance by patients was cited by only 48.6%. Thus, 40.8% saw little negative impact on the introduction and use of remote monitoring, and 10.5% saw no negative impact at all.

**Financial advantages from remote monitoring**

The (expected) positive effects of remote monitoring were perceived more clearly, and hence cited more
often, by those who were already using remote monitoring in their professional life (Figure 3). Prior experience with remote monitoring seems to have a positive effect on the opinion of doctors. In almost all areas surveyed, the current users saw a significantly greater financial benefit than non-users. The most significant differences between the prior use and non-use of remote monitoring were seen in the improvement of patient autonomy (p = 0.006), time savings for patients (p = 0.004), and the improvement of communication between doctor and patient (p = 0.009). Here, physicians already using remote monitoring saw the long-term financial success much more positively.

**Discussion**

The telemedicine market in Germany is highly dynamic, and there is no comprehensive telematics infrastructure so far. Pilot projects and isolated contractual applications still dominate the market. The development of telemedicine in Germany is facing key challenges. In addition to the establishment of a clear legal framework, ensuring information security, safety, 

**Table 4. Aspects with a negative impact on implementation**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>strongly agree</th>
<th>agree</th>
<th>disagree</th>
<th>strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>implementation costs</td>
<td>69.7%</td>
<td>27.6%</td>
<td>2.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>lack of funding agreements</td>
<td>73.7%</td>
<td>23.0%</td>
<td>2.0%</td>
<td>1.3%</td>
</tr>
<tr>
<td>unclear financing models</td>
<td>61.6</td>
<td>28.5%</td>
<td>7.9%</td>
<td>2.0%</td>
</tr>
<tr>
<td>nonspecific financial advantage</td>
<td>56.6</td>
<td>32.9%</td>
<td>8.6%</td>
<td>2.0%</td>
</tr>
<tr>
<td>lack of investment funds / resources</td>
<td>57.6</td>
<td>31.1%</td>
<td>9.9%</td>
<td>1.3%</td>
</tr>
<tr>
<td>reimbursement (billing) problems</td>
<td>58.9</td>
<td>25.8%</td>
<td>12.6%</td>
<td>2.6%</td>
</tr>
<tr>
<td>double structures by incompatibility</td>
<td>48.0</td>
<td>34.2%</td>
<td>15.1%</td>
<td>2.6%</td>
</tr>
<tr>
<td>operating costs</td>
<td>43.7</td>
<td>31.8%</td>
<td>23.8%</td>
<td>0.7%</td>
</tr>
<tr>
<td>lack of willingness to pay in patients</td>
<td>46.4</td>
<td>29.1%</td>
<td>19.9%</td>
<td>4.6%</td>
</tr>
<tr>
<td>lack of acceptance by patients</td>
<td>24.3</td>
<td>24.3%</td>
<td>40.8%</td>
<td>10.5%</td>
</tr>
</tbody>
</table>

**In what aspects do you see a financial benefit in the long term?**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>remote monitoring non-user</th>
<th>remote monitoring user</th>
</tr>
</thead>
<tbody>
<tr>
<td>interdisciplinary cooperation (p=0.032)</td>
<td></td>
<td></td>
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<tr>
<td>decrease of administrative costs (p=0.810)</td>
<td></td>
<td></td>
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<tr>
<td>individual health services (IGeL) (p=0.169)</td>
<td></td>
<td></td>
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<tr>
<td>competitive advantage (p=0.015)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>improved patient autonomy (p=0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>increased quality of care (p=0.018)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>higher employee satisfaction (p=0.023)</td>
<td></td>
<td></td>
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<tr>
<td>reduced waiting times for patients (p=0.015)</td>
<td></td>
<td></td>
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<tr>
<td>time savings for patient (p=0.004)</td>
<td></td>
<td></td>
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<tr>
<td>time savings for staff / doctor (p=0.584)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>improvement of communication (p=0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>more patient satisfaction (p=0.023)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
and the development of quality-related guidelines, future focus must be given to economic and funding issues. This study shows that barriers are mainly perceived to be associated with lack of financing agreements, unclear financial benefits, and the lack of funding models. The costs of implementation are not clear to most correspondents.

Other studies also point to the importance of economic and finance-related factors for adoption and acceptance by physicians.25-38 Practicing physicians in Germany lack information for telemedicine, with only 36% feeling sufficiently informed on the subject and almost two-thirds describing their level of insight (information) to be inadequate.2 The results of the present study explain this lack of information. Only 14% felt adequately informed of financial risks associated with use of the technology.

Availability of information and knowledge is of importance to any user, but particularly prior to a decision of adoption. This also illustrates the discrepancy identified between the expected positive effects of the use of technology and the actual observed experience of the interviewed doctors who already use remote monitoring. In almost all dimensions queried, the current users see a significant financial advantage through telemedicine. Actual experience with the use of remote monitoring appears to have a positive effect on the attitude of doctors and also on long-term use orientation. However, a moderating variable here could be an individual’s technology affinity, or a general innovation competence, or affinity of the users.

Some studies point to the variables ‘gender’ and ‘age’ as a determining factor influencing the attitude towards telemedicine.11-17 This could not be confirmed by the reported study due to use of a deterministic model and unevenly distributed samples. Overall, the results show that providers tend to perceive financial burdens as economic benefits in terms of remote monitoring applications. Their focus is on implementation costs, lack of funding arrangements and models, unclear financial benefits, and investment resources. The results thus confirm the acceptance model regarding the influence of financial aspects specified in the first step of this study.

Even though web surveys are an interesting and attractive means of data collection, methodological problems may occur. For example, the voluntary nature of participation may reduce representativeness and bias the sample. Even though over 200 physicians participated in the study, they represent only a small part of the population and are presumably more interested in eHealth than others (although conversely, most participants were non-users). Various correction techniques (e.g., adjustment weighting, use of reference surveys) could reduce the bias, but were not applied in the present study due to the lack of comparable values in the population.

Due to their key role in implementing telemedicine applications, healthcare providers need to be better informed about the possibilities and potential of this new technology. Furthermore, benefits need to be emphasised more strongly through studies and financing arrangements to encourage comprehensive implementation. This could also reduce existing uncertainties regarding the investment decision of healthcare service providers. Promoting a positive attitude amongst doctors also plays an essential role in the adoption of telemedicine by patients, as they often get their insight and direction from their healthcare providers. Further research is needed to more fully understand acceptance determinants, particularly regarding age and gender, and their effect on the outpatient and inpatient sectors.

Conflict of Interest. The authors declare no conflicts of interest.

Corresponding author:
School of Public Health
Bielefeld University
Universitätsstraße 25
33615 Bielefeld
Germany
E-mail: florian.leppert@uni-bielefeld.de
Tel: +49 521 106 4265

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