Technology Acceptance in Medicine – 'Telemedicine' – the perspective of the users

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Abstract

The interest intelemedicine has increased in the last few years. Technology now offers more potential for health applications than ever, and simultaneously, the demand for accessible and affordable health care is increasing.
Healthcare is becoming more patient centred. Patients are more than ever assuming the role of active customers, rather than passive elements.
The goal f this work is to understand what is the perspective of these “users” of telemedicine, concerning this increased use of technology. For this purpose the methods used were the following:
A literature review was conducted, approaching basic aspects of telemedicine, and examples of implementations in different contexts. A set of interviews to experts was performed, concerning their experiences on telemedicine, and transcripts were examined for relevant aspects. Two surveys were then elaborated: One directed towards 22 COPD patients who have been participating in a home telemonitorization pilot project; a second concerned 127 internet users, and had two parts: The first part calculated the users eHEALS score; the second intended to understand the importance these users attributed to advantages provided by Portuguese telemedicine projects and their expectation concerning whether these aspects would happen.
Data from interviews was qualitatively analysed. As for the data extracted from the surveys, software IBM SPSS Statistics was used. Besides statistical quantities such as means and Standard Deviations, statistical methods used were Exploratory Factor Analysis, through Principal Component Analysis, estimation of reliability of sets of items, using Cronbach Alpha and Mann-whitney test.
Expert interviews indicated that the patients and doctors do influence the success of telemedicine projects, but that these actors are also influenced by the attitude of the implementers of the same project and the by the strategy being followed; other external factors also influence this success. The survey to COPD patients demonstrated that despite technical difficulties by the part of the final users, good results can be achieved, with high satisfaction. The survey towards internet users resulted in a mean eHEALS value of **25,4**, It was confirmed that the scale is unidimensional and that it is consistent, with a good reliability. Concerning the second part of the survey, respondents attributed higher value to the importance of the advantages of telemedicine pilot projects, but a lower value to expectation. Importance was found to be unidimensional, and belief/expectation depended on two factors. A classification of the users according to these three factors was proposed, using cluster analysis.

Keywords: telemedicine users, users perspectives, telemonitorization, expert interviews, Principal Component Analysis

1. Introduction

Technology is changing the way we interact with health. As information is becoming easily available, patients who are informed and make research concerning their health are becoming more common. This knowledge is changing their behaviour, that is becoming less passive and more customer-like.
As for health professionals, things are also changing: They have easier access to the most current studies, and are able to share their experiences and be aware of the state of their

patients at all times.
Interactions between actors in telemedicine are important, since they play a role in the success of the implementations. Even though telemedicine has been around for a while, scalability of the projects is still a problem; adherence of the users to these services are one of the factors determining their sustainability.
Also, the current technologic context appears to promote a healthcare that counts more on the participation of patients as active elements.
The goal of this work is to analyse the perspective of the users of telemedicine, i.e., patients and health professionals and to identify which of these factors contribute to the success of telemedicine implementations.

1.1. The context of telemedicine

Telemedicine, telehealth, eHealth and telecare are all terms often used interchangeably to refer health provided through electroninc means, at a distance. Some authors, such as Van Dyk, refer to eHealth as an umbrella term, involving the other concepts.
The American Telemedicine Association defines telemedicine as the providence of healthcare at a distance, through the use of Information Communication Technologies.

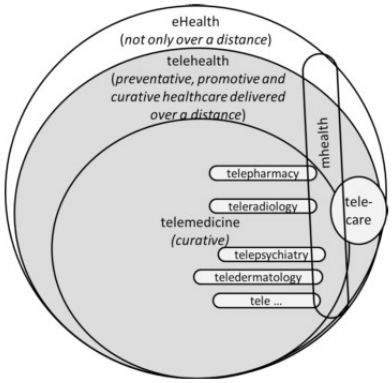


Figure 1 – Organization of concepts included in e-Health;

Telemedicine, as defined by ATA dates back to the beginning of civilization, where smoke signals were used to advert other tribes and outsiders of an epidemic in a village, for example.

Through out history there are reports of different means of communication being used to provide medical care, such the telegraph, radio, and telephone.

In the US, NASA is commonly referred to as the first to make use remote vital signal monitoring, for the astronauts in space travelling.

Most recently, interest in telemedicine has increased, as the demand for accessible affordable care is also increasing. Simultaneously, the way healthcare is seen is also changing, and the generalization of Smartphones and broadband access bring opportunities of new health applications, and healthcare providence centred on the patient.

Telemedicine services are often classified in three categories: Real-time or Synchronous, in which there is direct interaction between the interlocutors, Store and forward or Assynchronous, in which in which there is a time delay between the sending of the data and its reception, and home telemonitorization services, in which data is transferred from the patient to the clinician, in real-time or not.

Not all medical specialities are equally prone to the use of telemedicine and some applications are notoriously more popular than others. Here, three of the most common applications will be referred in more detail, in the next sections.

1.2. Teleradiology

Teleradiology largely depends on the observation of medical images. The transmission of images between different geographical locations has been around for more than fifty years, making telerradiology the mos widely available telemedicine application.

Great improvements have been made in the last decade with the combination of PACS with high bandwidth internet connections has facilitated the transmission of medical images between different locations for diagnostic purposes.

1.3. Telestroke

Stroke treatment is highly time-dependent. The application of telemedicine to stroke treatment has been possible due to the advances in terms of real-time communications.

The use of tissue plasminogen factor (tPA) is one of the most effective treatments, provided it is administered 3-4,5 hours after symptom onset. Only 2-4% of acute stroke patients actually receive tPA treatment, usually due to late presentation of the patient or lack of specialists with the expertise to perform its administration.(Dignity Health, n.d.)

Typical equipment for telestroke systems includes high speed internet with IP or ISDN connection, high quality videoconferencing capabilities (including zoom, tilt and pan cameras with independent operation), Computer Tomography or brain image transfer capability and secure image

formats.

In a pilot investigation, Robinson, Turner, & Wood, 2015 assessed perceptions of acute care telemedicine of 100 stroke patients who had teleconsultations with a neurologist following a stroke. 38% of the patients considered their treatment to be excellent, and 30% considered it to be above the average. Describing the effectiveness of the technology that was used, 89% of the patients did not experience a single technical problem and 95% had no problems understanding the neurologist during the consultation. Generally, the study demonstrated a high level of satisfaction.

1.4. Teleopthalmology

Teleophtalmology has been gaining importance as an eye-care modality worldwide, and its use is quite common for screening and speciality referral for common eye diseases.

In paediatric medicine the most common is screening and timely care of retinopathy of prematurity(Tehrani, 2014)

Among the geriatric population teleophthalmology services include diabetic retinopathy screening and referral, age-related macular degeneration and other eye-sight threatening diseases. Glaucoma screening and comprehensive vision screening and refractive error services are other successfully implemented applications.(Sreelatha & Ramesh, 2016)

Results for teleophthalmology projects have been generally positive, with outcomes similar to those of traditional ophthalmology. Results for teleophthalmology projects have been generally positive, with outcomes similar to those of traditional ophthalmology (Sreelatha & Ramesh, 2016)

1.5. Telepsichiatry

Mental illness is a widespread issue world wide and estimates indicate that the prevalence of neurological and mental disorders is increasing, with a raise of 15% in 2020. (World Health Organization, 2001)

Interventions using telephone calls appear to benefit some patients with mild-to-moderate health problems, for example. However it may be more effective to combine telehealth with specific therapy with proven effectiveness, such as cognitive-behavioral therapy.(Savita Malhotra, 2013)

One of the great advantages of remote monitorization is that it allows the physician to check on his patients more often.(Campbell, O'Gorman, & Cernovsky, 2015)

In terms of costs telepsychiatry to distant sites is less expensive than conventional psychiatric treatment and may be as effective across a several diagnostic categories.(S. Deslich et al, 2013)

Promising applications include installation of telepsichiatry systems in schools and correctional facilities.

School systems are using counselling services in the school campus, and they pay these services in an as-needed basis.(S. Deslich et al 2013)

As for prisons, access to healthcare is very limited among the inmate population for several reasons, First, the costs of transportation are high. For the transportation of one inmate, prisons usually allocate two staff members, which also brings the risk of leaving the prison understaffed. Additionally, there are security issues, for the external population the treating facilities. Some professionals are reluctant in treating inmates in their clinics.(S. A. Deslich et al 2013)

However it remains difficult to judge its effectiveness because there are few clinical outcome studies and the populations adequate for telepsychiatry are limited.

1.6. M-Health

While no standardized definition of m-Health exists. The Global Observatory for e-Health opted to define it as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDA's) and other wireless devices". (mHealth New horizons for health through mobile technologies, 2011).

In the 90's, the PDA's appeared and made it possible for doctors to download medical records, lab results, medical images and drug information. The mobile technology evolved in a very rapid manner since then.

In 2007, Apple presented the I-phone 2G, with its operating system, the iOS. Other operating systems followed, and currently, iOS and Android dominate the market, with their online application stores, that offer or sell a variety of applications. (Silva et al., 2015)

The advent of Smartphones, supporting 3G and 4G mobile networks has made mobile computing an attraction for research and business communities. (Silva et al., 2015)

In 2015 the world population had an estimated value of approximately 7,1 billion and the number of mobile phone subscriptions was in 7,085 billion.

1.7. MHealth in Africa

In many regions of Africa, basic access to healthcare is a challenge and m-Health has the potential to provide remarkable development opportunities.
Mobile penetration in Sub-saharan Africa is close to exceeding 80%, and mobile phones are being used as important tools for business and services, besides basic communication functions.(Deloitte Center for Health Solutions, 2014)
A wide range of m-Health services have been successfully used for treatment compliance, diagnosis and treatment support, some based in technologies as simple as text messaging. More complex applications consist of complete system infrastructures, that allow remote monitoring and audio-visual communication in real-time between patients and providers.

1.8. Comparison between three countries

While telemedicine is becoming more popular around the world, initiatives for telemedicine vary from country to country, according to several aspects. Two important of these aspects are the type of issues telemedicine aims to solve and the budget available for such initiatives.
In this section, three countries will be used as examples: United States, the country in which telemedicine is said to be in a higher stage of development; Australia, another highly developed country, in which telemedicine is seen as a solution for the inequalities between large urban areas near the coast, and low densely populated remote regions; healthcare priorities are related to specialized care in rural regions, specifically to indigenous population and ageing population care. India has a middle low development level. Telemedicine aims to provide better delivery of care in order to compensate for the shortage of health professionals, when compared to the huge population.
The differences between these countries reflect in the type of opportunities, barriers and stage of development of telemedicine.
Most prominent barriers to large scale implementation of telemedicine in the US are related to reimbursement and licensing laws, which present considerable variations from state to state. The interest by telemedicine has particularly grown since the Affordable Healthcare Act (ACA). While ACA itself includes several telehealth related measures as cost-saving solutions, as the number of insured Americans is increasing, so is the demand for healthcare.
In Australia, telehealth currently is mostly directed towards providing remote regions with specialized care. Some barriers that are mentioned in literature are related to difficulties with expanding projects. There has been a growing interest in telemonitorization and telemedicine initiatives related to chronic diseases and aged care.
India, on the other hand, has had several telemedicine experiences, but most do not expand. Barriers in India have diverse natures, but many are related to the lack of human and material resources.

1.9. Actors in telemedicine

As mentioned by Mevish P. Vaishnav (2014) people involved in telemedicine projects influence the outcomes of these projects.

Actors have been seen as initial barriers to the implmentation of telemedicine projects.

These users might rely on a previously used method, and be reluctant to accept the new technology. Among clinicians, a certain scepticism is common towards telemedicine. Assuring the clinicians of the reliability of the technology and capacity of providing enough information for an adequate clinical decision is fundamental
In telemedicine, referring to users can be ambiguous. In several types of telemedicine, while the individual using in fact the application, in the technical sense, might be a doctor, the final user, who benefits from the health service is a patient.
On the other hand, other services, such as home telemonitorization, the patient, or his carer, are actually involved in the technical part.
It could be hypothesized that doctors and patients have to different kinds of effects on telemedicine acceptance: First, an effect as users of the technology, which depends not only on their previous beliefs about telemedicine and the technology being used, but also on how they actually perform when dealing with this technology; second, an effect that is more conceptual, such as a passive resistance; an example could be a patient who is distrustful of teleconsultations. He might be reluctant in participating, but in many cases, specifically due to the use of telemedicine when conventional consultations are not accessible, he will end up going to the consultation, and the effect of his beliefs is minimal, since the doctor is the “user”. On the other hand, distrust of population in general might still have a residual effect, at least as a part of the public opinion. This is in line with the opinion of (Nate M. Lacktman, 2016) that the opinion of patients does have an important role in telemedicine implementation, as one of the major

forces driving this implementation is their demand for accessible and affordable healthcare.
This is related to the concept of patient engagement, defined by Angela Coulter as Advanced Encounter.

LeRouge et al (2012) elaborated a model intended to represent relations established by actor in the particular case of teleconsultations, they called advanced encounter, illustrated in Figure 2

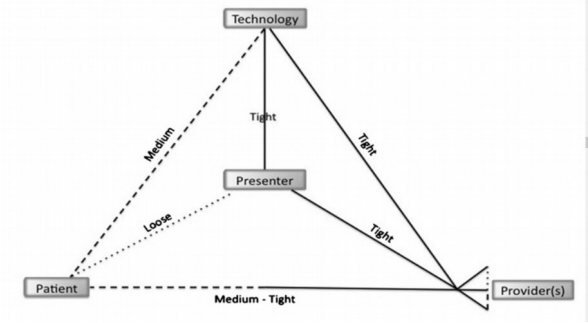


Figure 2 – Advanced Encounter, as modelled by LeRouge et al (2012)

It has been shown that medical professionals play a major role in the sustainability of telemedicine projects. (Wade et al, 2014) proposed “clinician acceptance” as a key factor for sustainable telehealth services, based on their multi-factor meso-level model. Other factors related to clinicians were clinician workforce availability, positive beliefs about telehealth, good relationship between professionals and clinician's demand for services.

Besides the initial adherence, another important component for the sustainability of telemedicine projects has to do with the long term commitement of the professionals involved. Paul & McDaniel, 2016, for example, showed that one of the two major factors determining the participation of clinicians in a telemedicine service was time constrainment. While in a short term the professionals were willing to allocate extra time for the projects, on the long run their participation decreased.
The second factor they identified was related to the sense of professional isolation felt by doctors on the remote sites, which increased with a perceived inability to provide quality care in those circumstances.

1.10. Overcoming barriers related to the actors

A common strategy to facilitate this acceptance among the participants in telemedicine projects, is making technology more user–centred, and focused on quality. makes the following recommendations:

Determining the value of the project for society and actors, by emphasizing its advantages

Adopt technology according to the users needs.

Realizing that as with innovations in other industries, in the health industry adoption follows an S shaped logistic growth curve. This, along with frequent monitoring of the adoption should be helpful to establish better strategies in future implementations.

- Showing evidence of cost effectiveness
- Providing education, through someone with an enthusiastic attitude and enough skill on the use of the technology
- Keep client records specifying end-usability, quality certification and legal requirements should be taken into account.
- Encouraging clinicians to include telehealth sessions in their practice through training
- Financial and professional incentives for health professionals, upon using the technology.
- The placement of equipment should take into account convenience for the users.
- Following user privacy and consent protocols
- Showing evidence of cost effectiveness
- Establishing fixed methodology established for satisfaction surveys conduction, to allow periodic analysis.

2. Methodology

After literature review, the first step of this work consisted on a set of nine semistructured interviews to experts, I.e., individuals involved with different degrees in telemedicine.
Second, a survey was elaborated and distributed to COPD patients who have participated in a home telemonitorization experience.
Finally, a second survey was directed towards internet users. This survey consisted on two distinct parts: The first was a set of questions belonging to a scale called eHEALS, which intends to evaluate the respondents eHealth literacy level. The second, asked respondents about the importance they attributed to advantages of telemedicine projects currently operating in Portugal and the expectation they had of whether these aspects would actually happen.

2.1. Expert interviews

Nine interviews were performed. Experts were found through literature, organization websites and conferences of e-Health. The contacts were established via email.

In all cases the interview was made presently, except for one, which was made through a phone call. In one case it was not possible to record the conversation and notes were taken instead.
Records were fully transcribed and each paragraph was analyzed and assigned a topic.
Main topics were resumed and interpreted.

2.2. Survey to COPD patients

The survey was distributed to 22 COPD patients, belonging to two groups who had been participating in pilot home telemonitorization project.
15 surveys were distributed presently to the patients and 7 were send by mail.
The survey had 19 items, grouped in 8 categories, as shown in table I.
Results were analyzed in a descriptive manner. Additionally, the patients were divided in two groups, according to whether they belonged to one company group (Vital Mobile) or another (Hope Care), and Mann-Whitney test was used to evaluate whether these two groups presented significant differences for any of the variables on the survey

Table I – Variables and items used in the survey directed towards COPD telemonitorized patients

F – Fear for the quality of the	**F1** Before being telemonitorized, I feared something might go wrong with the service **F2** Before being telemonitorized, my family feared something might go wrong with the service
D – Technical difficulties	**D1** Indicate the difficulty level of using the Smartphone/Tablet for the telemonitorization tasks **D2** Indicate the level of difficulty of using the medical equipment for the telemonitorization tasks **D3** Indicate the level of difficulty that you anticipated those tasks to have. **D4** Did you need help performing the tasks for the telemonitorization?
S – Feeling of safety	**S1** I feel safer for knowing that my health is being monitored **S2** My family feels safer for me, for knowing that my health is being monitored **S3** I feel that I need less direct surveillance by my family, now that I am being telemonitorized
L – Increase in knowledge	**L1** I have learned how to better understand signs that my health is getting worse. **L2** Due to the regular contact with health professionals, I have obtained useful information concerning my disease
H – Health benefits	**H1** During telemonitorization, I comply better with my doctor's instructions. **H2** I have avoided visits to health institutions during telemonitorization **H3** I value being able to avoid going to health institutions
P – Feeling of privacy	**P1** Before being telemonitorized I feared that I might have feelings of privacy invasion **P2** I feel my privacy invaded
St – Satisfaction	**St1** The number of times I have been contacted by medical professionals during telemonitorization was appropriate **St2** There were situations in which I feel that direct contact with medical professionals would have been preferable **St3** There were situations in which I felt dissatisfied with the telemonitorization service

2.3. Survey to internet users

The survey was elaborated on Google Forms, and it was divulgated by sharing the link on Facebook, or sending it through email to possible respondents. It had two main parts.

2.3.1. User e-Health literacy

The first part of the survey had the goal of evaluating the predisposition of the respondents for using information technologies for health. The scale eHEALS evaluates the e-Health literacy level, in particular the skill of the respondents for using internet for searching matters related to health.
Two items were added to the original scale, UL4, and UL5, which evaluated respectively whether the respondent preferred to search for health pages from Portugal, and whether they merely used search engines for the their health research.
First, descriptive analysis of the sample was performed.
Second, since some binary variables allowed to divide the respondents in two groups (i.e., males vs females, those who have a chronic disease vs those who don't, etc) Mann-Whitney test was used to evaluate whether some of the UL variables presented significant differences in their medians for both groups. In the cases were differences were found, Levene's test was used to evaluate whether the variances of the distributions can be considered equal.
Finally, PCA was used to evaluate the consistency of the scale, as modified by adding UL4 and UL5, and for the original items. Cronbach alpha was used as a reliability measure; the minimum established value for alpha used in this work was of 0,7.
The analysis was validated by the observation of the results for KMO and Berletts Sphericity test. Items presenting commonalities lower than 0,4 were excluded.
To choose the number of factors, the criteria followed were the Scree plot rule, i.e., only accepting factors appearing before the major inflexion of the curve in the scree plot and the kaiser rule, that states that factors should be higher than 1

2.3.2. Perspective on Portuguese Telemedicine Projects

PCA was used, and several different arrangements of items were tested, applying the same criteria as above.
For one of the results, the scores calculated by the same analysis were then used to calculate regression scores for each factor, that were further used for cluster analysis classification of the respondents.
Two methods were used for this: 2-step clustering (since it does not require specification of a number of cluster centers) and k-means clustering, using the number of clusters acquired previously.

3. Results

3.1.1. Expert interviews

3.1.1.1. Definition of telemedicine

All experts inquired during this work were involved to some level with telemedicine and thus had positive opinions about it.
One interesting finding was the type of definition they attributed to telemedicine.
One expert actually described it as an umbrella term. But then added that it was not a specialty, it was a channel through which the same service is provided.
Most experts however, focused more on the aspect of increased communication, and less in the means used for this, I.e., technological aspects.

3.1.1.2. Benefits of Telemedicine

Benefits mentioned by experts were similar to those reported by other sources as benefits of telemedicine.
Overall, three different benefits were mentioned:

- **Equity of Access**
- **Decreasing Costs**
- **Formation of professionals**
- **Commodity for patients**

3.1.1.3. Barriers

As for barriers, a common barrier mentioned by experts concerned fear of medical error. However, this was never mentioned as a barrier that the subjects who were involved in implementations had actually suffered.
Barriers that provided difficulties for implementers were often related to bureaucratic and financial issues. Resistances that were mentioned were attributed to ho**spital administrations and medium .**
Concerning the government, one project from 1999 mentioned the lack of support, which strongly implied a lack of interest. For the part of another, current project, it was mentioned that the results had been praised, indicating that there is interest, but also reluctance in funding the expansion of the project despite good results.
Other expert mentioned that Health ministry has been very supportive, in terms of providing legislation and conditions for the practice of telemedicine.
On the part of patients, no resistance was reported by those involved in projects.

3.1.1.4. Factors of success

A list of factors mentioned during the interviews, concerning both projects that are ongoing and others that happened before, was elaborated:

3.1.1.4.1. Sharing responsibilities with other health professionals

Two of the experts involved in successful projects mentioned “Team work” as one of the factors of success. In one case, the involvement of nurses, for the COPD home telemonitorization, as a first line of assistance for the patients was very effective.
Telemedicine is often used to compensate for the lack of experts. While there is the support of a specialist at a distance, the “presenter”, i.e. the health professional with the patient has to assume extra responsibilities.

3.1.1.4.2. Partnerships with technology providers

In one of the projects, a good collaboration with a technical provider contributed to the good results. It was mentioned that the clinical team should attend health manners, but that a technical source of support was useful, particularly one that was in sync with the goals of the project.

3.1.1.4.3. Adapting to the circumstances

Another commonality between the projects that have achieved good results has to do with a capacity of adapting the project and the objectives to the reality of the users. In the case of COPD home telemonitorization, it was essential to simplify at most the use of the technology. For the project “Saúde para Todos” in IMVF, many adaptations were made, in terms of cost reduction and resource saving.

3.1.1.5. Patients perspective

Experts who had interacted with patients who had participated in teleconsultations mentioned that most were very willing to attend a consultation in this way, rather than a conventional one.
In the case of home telemonitorization, were patients assume a more active role, adaptation appears to have been more difficult, but attending to the results, it was possible.

3.1.1.6. Portuguese healthcare model

A topic referred several times was the need to change the current healthcare model, to a model more directed towards continued care and aging care. Specifically, it was mentioned that a model like this would probably benefit more from telemedicine.

3.1.2. Survey to COPD patients

3.1.2.1. Description of the sample

22 responses from COPD patients were acquired. The majority,12 patients, belonged to the age interval of 71-80 years old, 1 was between 40-50 years old, 4 were between 51-60, 3 were 61-70 and 2 were older than 80 years old.
As for education level, 13 patients reported having Elementary school education, 1 reporting having no education at all, 4 reported having High School education and other 4 Higher education.
In the full set, there were only 3 female respondents.
14 patients reported having answered the survey themselves while the other 8 surveys were answered via a carer or relative.

3.1.2.2. Comparison between the two groups

Overall, two main groups of patients could be distinguished, since the pilot project involved groups managed by different technical and clinical teams. 9 of the 22 users belonged to a group managed by company Hope Care and 13 by company Vital Mobile.
Mann-Whitney was used to find differences between scores for each group.
The variables for which significant differences were found between the two groups were:

- F3 Vital Mobile group's mean rank was higher (15,08) than Hope Care's (86,33), with $p = 0,001 < 0,05$.
- U Hope Care scored higher, with mean rank of 16,22 versus 8,23 and p=0,002
- S1 Vital Mobile scored higher, 13,46 and Hope Care 8,67 (p=0,034)
- S2, in which the differences were also significant, Vital Mobile scored 15,31 versus 6,00, p=0,00.
- H1 and H2, that evaluate health benefits, Vital Mobile scored higher, 14,08 and 13,92 vs 7,78 and 8, and p=0,011 and p=0,017.
- L3, Vital Mobile was significantly higher than Hope Care, 13,85 vs 8,11 and p=0,014.

While Mann-Whitney is a non-parametric test, and can be applied to independent samples, even if they have different number of elements, the power of the test decreases with the differences between the sizes of the samples. In this case, one sample is of size 9 and the other of 13.
Another factor that might have influenced the results has to do with the comprehension of the respondents. There was the opportunity to interact with some of the patients, in particular 6 patients from Vital Mobile. While they were visibly satisfied

with the service and its benefits, they reported having already a good relation with their physician, and being very trustful towards experimenting telemonitorization. On the one hand, this might ave influenced the results, as patients tended to be eager to answer positively. On the other hand, the results are still evaluating somehow a degree of satisfaction with the service, which undoubtedly contributed to its success, and thus this is indicative that the relationship with those involved does contribute to the success of the projects.
Some patients also had some difficulties answering. While there was the opportunity to help fill the questionnaire for 6 of them, others answered alone or were helped by other people, and thus results might be biased.

3.1.2.3. Overview of the results

Since the sample being used is quite small, for an easier interpretation of the overall opinion of the patients, the scale was converted to a positive/negative scale

3.1.2.3.1. Difficulty - D1-D3

59,09% and 81,82% of the patients reported that using the Smartphone (D1) and Medical equipment(D2), respectively, had been “Easy” or “Very Easy”.
36,55% reported expecting these tasks to be “Easy” or “very Easy” before starting.
While these results reflect an overall facility in performing the tasks, elements from the technical team of the group mentioned several difficulties by the part of the patients. This impression was also confirmed while interacting with patients and their caregivers: Often, patients would report that the tasks were very easy, but caregivers would disagree. Also, the value of patients who reported not needing help ever, or just at the beginning was of 54,55%.

3.1.2.3.2. Increased feeling of safety – S1-S3

90,91% agreed or fully agreed that they felt safer, 81,82% that their families felt safer and 77,27% that they needed less direct surveillance.

3.1.2.3.3. Learning – L1 and L2

40,91%, 50,55% and 86,36% of users agreed or completely agreed that they had “learned how to identify signals and symptoms of my health decrease” (L1), “Comply better with doctor prescriptions”(L2) and “Learned valuable information concerning my disease and health status”(L3) Again, some inconsistency is noticeable, due to the variation between answers to L1 and L3.

86,36 answered positively about having “Avoid visits to health institutions (H1)

3.1.2.3.4. Privacy

While only 95,45% of users not expecting feelings of privacy invasion, 100% did not really felt any privacy invasion.

3.1.2.3.5. Satisfaction

Variables S also had high values, in particular all patients reported thinking the number of times they had been contacted had been adequate.

3.1.2.3.6. Use of Smartphone/Tablet for other activities

Only 13,64% of patients answered positively about having started to use the Smartphone for other tasks.

3.1.3. Survey to internet users

3.1.3.1. Description of the sample

A convenience sample of 127 responses was acquired.
The number of female respondents(N = 73, 56,6%) was slightly superior to the number of male respondents(N=55, 43,3%).
Overall, ages of respondents were between 18 and 86 years old with M=35,65, SD=16,02.
Concerning their education level, 77,2% respondents (n=98) reported having higher education, 20,5% (n=26) said they had “Highschool Education” and 2,4% (n=3) reported having “Elementary School” level education. As the number of respondents belonging to the “Elementary School” was quite small, respondents were regrouped in having “Higher Education” or “Non-higher Education”.
Observing the distributions of respondents in education level, it is noticeable that this sample is not representative of the Portuguese population (http://w3.dgeec.mec.pt/dse/eef/indicadores/Indicador_1_5.asp), since according to the National Institute of Statistics (INE), only 31,4% of Portuguese adults had completed higher education studies in 2015.
The mean used for the distribution of the survey was social networks, which justifies these distributions for ages and education level. Many respondents are likely to belong to the same social network, for example, having attended the same institutions.

Finally, respondents were asked whether they suffered from a chronic disease and whether they had a close friend or relative suffering from one. Despite the small sample size, specifically for older age groups, there is an expected increase in proportion in the number of respondents with chronic diseases versus those without with the increase in age group. Overall, 29,9%(n=38) respondents reported suffering from a chronic disease and 53,5% (n=68) reported knowing someone suffering from one. From the 52 male respondents 34,5% (n=19)suffered from a chronic disease and from the 72 females, also 15% (n=19) were chronic disease patients.

Mann-Whitney test was used on “Chronic disease patients” vs “Non-chronic disease patients”. Since U=1076, n=19, n=19, p=0,001, the difference between the mean ranks is significant. Levene's test confirmed that it is assumable that the distributions share the same variance. Thus, the median of ages for chronic disease patients is higher, as expected.

Table II – Percentages of answers to demographic items in the survey directed towards internet users;

		gender			
		male		female	
		N	%	N	%
Education	Non-HE	12	41,4%	17	58,6%
	HE	43	43,9%	55	56,1%
CD1	Yes	19	50,0%	19	50,0%
	No	36	40,4%	53	59,6%
CD2	Yes	33	48,5%	35	51,5%
	No	22	37,3%	37	62,7%
T1	No	10	38,5%	16	61,5%
	Yes	45	44,6%	56	55,4%
T2	No	42	44,2%	53	55,8%
	Yes	13	40,6%	19	59,4%

3.1.3.2. User's e-Health literacy

For every item, minimum value attributed to each item was 1 and maximum was 5.
Highest scores were achieved for item UL4, and lowest for item UL2.
From the original scale, the item with highest score was UL9.
Mann-Whitney test was performed, dividing the sample in two groups, according to their answers to item T1. Only for the answers to items UL1, UL6 and UL10 were any significant differences noted in the medians.
The same test between performed, but by grouping respondents according to their answers to item T2: (T2=yes) and those who didn't (T2=No) revealed that those who answered yes, scored higher in the items UL2, UL3 and UL10.
No significant differences were observed in the answers to UL items, when grouping the respondents according to their education level or whether they had a chronic disease.

3.1.3.3. PCA and reliability analysis

The value of KMO for UL1-UL10 was of 0,823, which according to Maroca (2004) is a “good” recommendation for applying PCA. Barlett's Sphericity test had a significance of approximately p=0,0 <0,05, another indicator that the sample is appropriate for PCA application.
Observing the communality matrix, values for items UL2, UL3 and UL5 are respectively 0,460, 0,463 and 0,409, which are quite low; still, the analysis was continued.
For the items UL1-UL10, two components were first extracted with eigenvalues higher than 1. Component 1 is responsible for 45,487% and 44,445% and component 2 for 12,992% and 13,964% of the variation without rotation and for Varimax respectively. Together these estimated components explain 58,409% of the variance, which is above the minimum acceptable of 50% .
The scree plot was computed and is in line with two main representative components, with the major inflexion of the curve in component 2, the last component with a value over zero.
Reliability for the second component, with contributions from variables UL4 and UL5, was only of alpha=0,299. This value is quite below 0,7 minimum established previously and thus UL4 and UL5 were excluded from the analysis.
Reliability for the first component, the value was of alpha = 0.851.
The value for reliability is of 0,851, which is acceptable. Rosalie van der Vaart (2013) and De Caro W & Marucci AR (2016) acquired higher values, of alpha = 0.903 and alpha=0,9. A possible explanation might be that the samples used were much more homogenous than the one used for this work (the second for example, was specifically administered for a group of undergraduate nurses).

3.1.3.4. EHEALS scores

For Paige, et al (2016).The average self-reported eHealth literacy score in this sample was of 30.34 (SD = 5.30; min = 8, max = 40), when applying the test specifically to 811 participants having at least one chronic condition, higher than the one obtained

in this case, of 25, 93. They report a mean age of 47,24 (SD=17,10); in terms of education, higher than ours and they mention that more than 70,2% reported at least some college level education. Thus, the respondents are older and the ones in this work appear to have a higher education level. Since this sample was of chronic disease patients, mean and SD were computed for ULS scores of the subgroup owing a chronic disease. For this sample, the group with a chronic disease had a ULS of M=26,07, SD=7,06, which is still lower than the values of the patients in Paige et al (2016).
Mann-Whitney test was performed between subgroups formed by binary variable CD1 **(“**having a chronic disease” vs “not having a chronic disease”) and Education(“higher education” vs “non higher education”) in order to understand whether differences in medians of these groups had any significance.
There was no significant difference in ULS scores for respondents who had a chronic disease (n1= “Yes”) and those who did not (n2=“No”) (U = 1647,0, n1= 38, n2 = 89, p = 0,816 > 0,05). Levene's test for homogeneity of variances was performed. P = 0,236 >0,01, thus the variances are assumed to be equal in this case
For variable T1 (Knowing the definition of telemedicine), there were also no differences between groups (n1=”No”, n2 = “Yes”), U=1053, n1 = 26, n2 = 101, p = 0,120)
For T2 (Being aware of Portuguese telemedicine experiences, n1= “No”, n2 = “Yes”), there were o significant differences (U= 1251, n1 = 95, n2 = 32, p= 0,135).
Education level (n1= “Higher Education”, n2= “Non-higher Education”) also did not seem to make a difference in terms of ULS score (U=1367, n1 =95 n2=32 p=0,761).
There was some expectation concerning the relationship between ULS and age, and education level, but none was detected in this sample. Rosalie van der Vaart (2013), also did not found a relation between education level, age and the score. However, for example, Choi & Dinitto (2013) who analyzed a sample of 980 in-bound older adults did detect a significant negative relation between eHEALS and age.
Again, Mann-Whitney loses statistical power as the differences between these groups increase, and this could affect the accuracy of these results.

3.1.4. Perspective on Portuguese projects

3.1.4.1. PCA and reliability analysis

Again, factor analysis was applied, combined with reliability analysis using Cronbach Alpha.

Due to the sheer number of items and the organization of the second part of the survey, there was the need to decide the best way of applying this process.
Several combinations were performed (as shown in Appendix).
The final decision was to Apply PCA to all positive A items and then to all B positive items, I.e.,applying PCA 2 times;

1. TD1-3, TC1-3 and TM1-3 for A
2. TD1-3, TC1-3 and TM1-3 for B

Standardized regression scores were calculated for each of the factors extracted, and were coded PCA (principal component A), PCB1 and PCB2 (principal components 1 and 2 of B).
Using a clustering method should provide a classification of respondents according to their scores, first in terms of the factor A and in terms of the scores for the two components in B.
2-step clustering
Two clusters were extracted: Cluster 1 contains 59 members and cluster 2 contains 68 members.
2-step clustering includes an evaluation of the model quality. In this case, the classification provided by IBM SPSS Statistics was “Fair”, close to “Good”, with a value of 4,9.

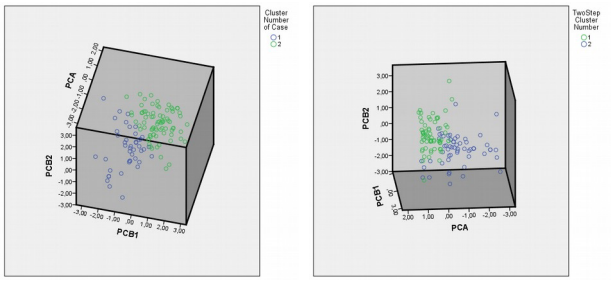
3.1.4.2. K-means clustering

As it is recommended to test clustering analysis for its stability k-means clustering was performed, specifying 2 clusters, the number obtained with 2-step clustering, in order to understand whether the results obtained were similar.
The two clusters obtained were Cluster 1 containing 76 members and cluster 2 containing 51 members.
Even though the cluster numbers are inverted (I.e., the k-means cluster 1 corresponds to 2-step clustering cluster 2 and vice-versa), the values of cluster centers and number of members per cluster are relatively similar. The number of members in the corresponding groups are also not very different.
In the following table X, results from each clustering method are presented.

Table III – Cluster centers and memberships, for data clustered according to the factors extracted through PCA in the survey directed towards internet users;

Cluster number		**1**	**2**
Method 2-step	**PCA**	-1,23	0,45
	PCB1	-0,84	0,31
	PCB2	-0,81	0,29

	Nº	68	0,59
k-means	**PCA**	0,58	-0,87
	PCB1	0,36	-0,54
	PCB2	0,52	-0,77
	Nº	76	0,51



Figures 2 a,b – Cluster representations for 2-step clustering and k-means clustering respectivelly

4. Conclusions

The goal of this work was to identify factors that contribute for the outcomes of telemedicine and specifically how the actors in telemedicine influence these outcomes.

When inquiring several experts, overall it was implied that the implementers have a strong role in the results. In particular, motivating other actors and adapting the project to the goals were factors of success.

The survey to COPD patients, who are in fact first hand users of telemedicine, confirmed the satisfaction that had already been reported. Although the results from this survey were not unexpected, it was clearly a case of adapting the technology to the user and not the opposite.

As for the second survey, first, the eHEALS score achieved for the sample was lower than the values reported in other studies, specially given the high level of education and that the respondents had a low men age. However, no relation was also found between the eHEALS scale and age or education; while unexpected, other works had reported the same.

The original scale also revealed a good consistency and the value of reliability achieved was good, even if lower that that of other studies.

Respondents appeared to have low awareness of Portuguese telemedicine projects, even though they did value the positive aspects they provide. As for their “belief” in those aspects, it had a lower value.

Importance seemed to be unidimensional, and the belief/expectation, depended on two factors. A classification based on these factors was also provided.

Appendix

Perform PCA separately to all sentences concerning an experience, and separating items A and B I.e., applying PCA 6 separate times for the following groups of items:

1. TD1A, TD2A, TD3A TD4A and TD5A,
2. TC1A TC2A TC3A TC4A
3. TM1A TM2A TM3A TM4A TM5A;
4. TD1B TD2B TD3B TD4B TD5B;
5. TC1B TC2B TC3B and TC4B ;
6. TM1B TM2B TM3B TM4B and TM5B.

Applying PCA to each group, ignoring the grouping according to A and B, thus applying PCA three separate times:

1. TD1-TD5, both A's and B's,
2. TC1-TC4 both A's and B's
3. TM1-TM5, A's and B's,

Applying PCA to all A items and then to all B items, I.e.,applying PCA 2 times;

1. TD1-5, TC1-4 and TM1-5 for A
2. TD1-5, TC1-4 and TM1-5 B

References

•BBC Research. (2014). *Mobile Health (mHealth) Technologies and Global Markets* (Vol. 7215).

•Britnell, M. (2015). *In Search of the Perfect Health System*. Retrieved from https://he.palgrave.com/page/detail/in-search-of-the-perfect-health-system-mark-britnell/?sf1=barcode&st1=9781137496638

•Campbell, R., O’Gorman, J., & Cernovsky, Z. Z. (2015). Reactions of psychiatric patients to telepsychiatry. *Mental Illness*, *7*(2), 54–55. http://doi.org/10.4081/mi.2015.6101

•Deloitte Center for Health Solutions. (2015). *Connected health How digital technology is transforming health and social care*.

•Deslich, S., Stec, B., Tomblin, S., & Coustasse, A. (2013). Telepsychiatry in the 21(st) century: transforming healthcare with technology. *Perspectives in Health Information Management / AHIMA, American Health Information Management Association*, *10*, 1f. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3709879&tool=pmcentrez&rendertype=abstract

•Dignity Health. (n.d.). Stroke Treatments. Retrieved from http://www.stroke.org/we-can-help/survivors/just-experienced-stroke/stroke-treatments

•Ferguson, E.W., Doarn, C.R. & Scott, J. C. J. (1995). Survey of Global Telemedicine. *Journal of Medical Systems*, *19*(1), 35–46.

•Field, Marylin J. Committee on Evaluating Clinical Applications of Telemedicine, Institute of M. (1996). *Telemedicine: A Guide to Assessing Telecommunications for Health Care*. National Academies Press, 08/11/1996.

•Hurst, E. J. (2016). Evolutions in Telemedicine: From Smoke Signals to Mobile Health Solutions. *Journal of Hospital Librarianship*, *16*(2), 174–185. http://doi.org/10.1080/15323269.2016.1150750

•IBM Corp. (n.d.). IBM SPSS Statistics v23.

•Jarosławski, S., & Saberwal, G. (2014). In eHealth in India today, the nature of work, the challenges and the finances: an interview-based study. *BMC Medical Informatics and Decision Making*, *14*, 1. http://doi.org/10.1186/1472-6947-14-1

•Mangan, D. (2013). Medical Bills Are the Biggest Cause of US Bankruptcies: Study. Retrieved from http://www.cnbc.com/id/100840148

•Matos, Rosa, Santana , Rui, Mendes Rita Veloso, Marques Ana Patrícia, Mestre, R. (2014). *Telemedicina em Portugal - Onde Estamos?* Fundação Calouste Gulbenkian.

•McFarland, D. J., & Hamilton, D. (2006). Adding contextual specificity to the technology acceptance model. *Computers in Human Behavior*, *22*(3), 427–447. http://doi.org/10.1016/j.chb.2004.09.009

•Mishra, S. K. (2012). Telemedicine in India: Country Report, (April), 18–20.

•Monteiro, M. H. (2007). Telemedicina Onde estamos e para onde vamos.

•ObamaCare Facts: Facts on the Affordable Care Act. (2016). Retrieved from http://obamacarefacts.com/obamacare-facts/

•Paige, S. R., Krieger, J. L., Stellefson, M., & Alber, J. M. (2016). Patient Education and Counseling eHealth literacy in chronic disease patients : An item response theory analysis of the eHealth literacy scale (eHEALS). *Patient Education and Counseling*. http://doi.org/10.1016/j.pec.2016.09.008

•Paul, D. L., & McDaniel, R. R. (2016). Facilitating telemedicine project sustainability in medically underserved areas: a healthcare provider participant perspective. *BMC Health Services Research*, *16*(1), 148. http://doi.org/10.1186/s12913-016-1401-y

•Prathiba, V., & Rema, M. (2011). Teleophthalmology: a model for eye care delivery in rural and underserved areas of India. *International Journal of Family Medicine*, *2011*, 683267. http://doi.org/10.1155/2011/683267

•Silva, B. M. C., Rodrigues, J. J. P. C., De, I., Díez, T., López-coronado, M., & Saleem, K. (2015). Mobile-health : A review of current state in 2015. *Journal of Biomedical Informatics*, *56*, 265–272. http://doi.org/10.1016/j.jbi.2015.06.003

•Sullivan, T. (2014). The real power of telehealth: Building large networks | Government Health IT. Retrieved May 3, 2016, from http://www.govhealthit.com/news/real-power-telehealth-building-large-networks

•Veterans Health Administration. (n.d.). Retrieved from http://www.va.gov/health/

•Welsh, T. S. (n.d.). Telemedicine. Retrieved May 3, 2016, from http://ocean.st.usm.edu/~w146169/teleweb/telemed.htm

•What is Telecare. (n.d.). Retrieved from http://telecareaware.com/what-is-telecare/

•*What is Telemedicine*. (2009). Retrieved from http://www.americantelemed.org/about-telemedicine/what-is-telemedicine#.VurNR-b4ZPY

•What Is The Difference Between Telemedicine, Telecare and Telehealth? (n.d.). Retrieved from https://evisit.com/what-is-the-difference-between-telemedicine-telecare-and-telehealth/

•World Health Organization. (n.d.). Millenium Health Goals. Retrieved from http://www.who.int/topics/millennium_development_goals/en/

•World Health Organization. (2001). *Mental Health - A Call for Action by World Health Ministers*.

•Zundel, K. M. (1996). Telemedicine: history, applications, and impact on librarianship. *Bulletin of the Medical Library Association*, *84*(1), 71–9. Retrieved rom http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=226126&tool=pmcentrez&rendertype=abs