Cost-Benefit Considerations of Post-clinical Telerehabilitation for Stroke Patients

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Abstract
The REHA2030-project aimed to implement telerehabilitation for stroke patients to be able to train at home. It included a robotic therapy device and support from therapists via the internet. The system was designed and installed on tablet computers for patients and therapists. Based on the field test a cost-benefit consideration was carried out to evaluate economic effects. After the identification of relevant cost and benefit parameters for telerehabilitation, data was collected and analyzed prior and after the field test. The focus was on the perspectives of patients, therapists, and relatives as well as the overall economic benefit. The main findings are: (1) Regarding the benefits, two out of three patients were very satisfied with their therapy; for therapists, the time needed for preparation was reduced; and for relatives, no transport services (and costs) were needed. (2) Cost savings per therapy amounted to 21.62 EUR per patient compared to conventional therapy. (3) Moreover, ten minutes more training time was reached compared to conventional therapy, which can be traced back to the increased level of motivation of the patients. It is critical to note that the costs can vary due to different conditions, e.g. many people already have a tablet and so costs might be lower. The generalizability of the results is limited by the small sample size (three patients and seven therapists), whereby the results have shown that this format encourages patients to exercise, which underlines results from other studies.

Keywords: Telemedicine, Cost-Benefit Considerations, Telerehabilitation, Stroke-Patients

Introduction and Aim of the Study

"*Move the information, not the patient*" (Jankowski et al., 2015, p. 118)

Stroke is a leading cause of disability worldwide and often people are affected, who are middle-aged or of working age. Telemedicine applications are known so far in the area of acute stroke care, but also in the fields of various therapies for stroke patients or their post-inpatient care; often speech therapy is cited (cf. Audebert et al., 2009; Bellomo et al., 2020; Mörsdorf & Beushausen, 2021).

The REHA2030-project was an interregional project in cooperation with partners from Slovenia and Austria, with the aim to provide telerehabilitation for stroke patients. Telerehabilitation should support the patients in their homes; they should be treated or get adequate therapy after the stroke in their homes, which is especially for people living in rural areas of interest. After the development of the technical solution (with a focus on a user-friendly device and the development of a robotic device for telemedicine), a field trial was carried out. Moreover, a service model for telerehabilitation was developed and a cost-benefit analysis was conducted (cf. Krainer et al., 2022). Within this paper, the results of the cost-benefit consideration are introduced and discussed. After the results of the literature review the methodology follows. Afterwards, we present and discuss the results of the analysis.

State of Research

The literature review led to several studies on telerehabilitation for stroke patients, with a positive effect on the motivation for training, a high level of commitment, especially due to the use of the technical device, as well as higher compliance compared to the intervention group (cf. Choi & Paik, 2018; Cramer et al., 2019; Dodakian et al., 2017). Improvements in the motoric functions of the upper limbs were outcomes (measured with standardized tests) and in some cases, the grip strength improved (cf. Burdea et al., 2020; Chen et al., 2020; Choi & Paik, 2018; Dodakian et al., 2017; Keidel et al., 2017; Rozevink, 2021). Alongside physical training, telerehabilitation showed improvements in cognition, a reduction of stress or depression and the acceptance of the technology (cf. Burdea et al., 2020; Maddahi et al., 2021). Besides the positive results also some criticism is stated, such as a very small sample size or the limited therapy period (cf. Choi & Paik, 2018; Qiu et al., 2020; Rozevink, 2021). In addition, technical problems were stated as negative aspects (cf. Burdea et al., 2020).

Regarding cost-benefit considerations on teletherapy, hardly any study contains detailed information of cost-efficiency. Kidholm et al. (2016) calculated the costs for telerehabilitation for patients with heart diseases in a randomized controlled study. With the result of higher costs for the teleintervention, mainly due to higher costs for equipment (5,709 EUR for teletherapy versus 4,045 EUR for the control group, cf. Kidholm et al., 2016). Contrarily, Llorens et al. (2014) calculated the telerehabilitation in comparison to hospital costs for people after a stroke and calculated 835.61 US$ per patient for telerehabilitation and 1,490.23 US$ for in-clinic rehabilitation. Hence, it was of great interest to carry out a cost-benefit analysis for the field trail of the REHA2030-study.

Methodological Approach

From a methodological point of view, the field test was evaluated with a cost-benefit consideration. Based on a literature research, the relevant indicators for telemedical

applications and telerehabilitation were identified and coordinated with the project partners. After the operationalization of the cost and benefit parameters, the collection of data was in focus, including a qualitative survey with patients and relatives, focus groups with the therapists and interviews with the project partners. In general, the perspectives of patients, therapists, and relatives, as well as the overall economic aspects were included.

The indicators were divided into main indicators and sub-indicators. Considering benefits, the main indicators represent the expected benefits for the main stakeholders (patients, therapists, relatives, and overall economic view). As can be seen in the following Table 1, the main indicator for the benefits for patients includes three sub-indicators: continuity and faster progress in therapy, increased therapy/training quality, as well as relief for patients (including time and financial relief). For therapists and relatives, time and financial relief were included as well. The overall economic benefit covers the relief for the health (care) system, the faster integration into the labor market and ecological effects.

Main indicator	**Sub-indicator**
Benefit for patients	Continuity and faster progress in therapy
	Increased therapy/training quality
	Time relief
	Financial relief
Benefit for therapists	Time relief
	Financial relief
Benefit for relatives	Time relief
	Financial relief
Economic Benefit	Relief for health (care) system
	Faster integration into the labor market
	Ecological effects
Technical intervention costs	Equipment and installation costs
	Operating costs
Costs for therapists/clinics	Costs for therapists
Development costs	

Table 1: Benefit and cost parameters (own source)

The cost parameters contain the costs for the technical intervention and the costs for the therapists/clinics (see also Table 1). The technical costs include the whole equipment (e.g. tablets, medical-therapeutic equipment PABLO®, SIM-card and tablet cases) and the installation as well as operation costs (e.g. electricity, internet, license fees, repair and maintenance, support costs). The costs for the therapists and clinics cover the personnel costs differentiated between teleworking and on-site working and insurance costs (professional liability insurance). Moreover, the development costs which were spent on the whole project were also calculated. Additionally, as seen in the literature (cf. Choi & Paik, 2018) the willingness to pay of the patients was asked in the questionnaire.

The qualitative survey was carried out with patients, therapists and relatives and additionally focus groups were organized to discuss several indicators. Starting in March 2022 and ending in June 2022, a total number of three patients (after stroke), seven therapists and one relative participated in the study. The period of telerehabilitation was between four and eleven weeks,

the therapists worked as freelancers or in clinics and covered the rehabilitation in the areas of physiotherapy, occupational therapy and speech therapy. Two of the three patients received all three therapy areas and one patient received only occupational therapy. In total, seven therapy processes were used for the evaluation. The average age of the patients was 52 years and 39 years within the therapists.

Results

The following paragraphs summarize the results of the analysis, distinguished between benefits and costs.

Benefit-Considerations

From the patients' point of view, the therapy progress was compared between the conventional therapy (on-site) and the teletherapy with REHA2030. The conventional form was rated twice as good and once as very good; comparatively, REHA2030 was rated twice as good and once as neutral. In detail, the patients reflected that their motor skills including balance, the quality of life, the speech abilities and the listening comprehension improved with the telerehabilitation. Nevertheless, patients rated the conventional therapy form better compared to telerehabilitation.

Moreover, the REHA2030 tool recorded the continuity of therapy with a total number of 558 therapy units done. This means that 173 more therapy units were done than originally planned. Specifically, one patient completed 296 occupational therapy sessions instead of the planned 110, while the other two patients completed the planned number or less (131 out of 131 and 120 out of 144).

To further assess training continuity, patients and therapists were asked about their subjective assessment of the number of training sessions. Two patients answered that they had trained more in their opinion and one patient said that it was the same with the standard therapy. The therapists stated that all patients exercised more in the different types of therapy. Increased motivation led to increased training performance in one of three cases.

Considering the therapy/training quality, two out of three participants were very satisfied with REHA2030, but two patients also stated that there should be more variety of exercises in order to not get bored by the training. Likewise, the therapists rated the telerehabilitation with the patients as very satisfied to satisfied (four times very satisfied, three times satisfied). The practicability of the system was assessed as positive by patients, since guidance and monitoring of the tasks completed were helpful and the system was easy to acquire. The same was stated by the therapists, plus the possibility of feedback sessions.

The relief for the patients was measured by time spent and financial expenses. In terms of time, the three patients required on average 40 minutes for conventional therapy, three times per week, which resulted in approx. two hours of therapy per week. The teletherapy lasted on average 79 minutes for the asynchrony sessions and around 51 minutes for synchronic sessions per week. This resulted in an average training duration of approx. 2.2 hours per week. It is important to note that asynchronous telerehabilitation includes exercises and synchronous includes video calls (and real-time exercises) with the therapists. This means that teletherapy lasted approx. ten minutes longer time per week than the standard therapy format. But besides training time, travel time for patients to the place of therapy have to be

considered. For example, a journey time of 30 minutes one way (25 kilometers) was calculated for one participant. Thus, one hour of travel time was saved on average three times per week compared to conventional therapy.

The financial relief for patients was calculated at around 65 EUR per week, as the driving (25 kilometers) will cost around 21 EUR per training (calculated with official kilometer allowance in Austria; 25*2*0.42; for more information see Austrian Federal Ministry of Finance, 2022).

From the therapists' perspective, a time relief was calculated for each functional therapy form. The calculation was carried out with standard therapy versus teletherapy. Occupational therapists need around 132 minutes for standard therapy, speech therapists 70 minutes and physiotherapists 250 minutes per week. For teletherapy, an occupational therapist needed about 79 minutes per week, a speech therapist about 131 minutes per week and a physiotherapist about 166 minutes per week. This means that occupational therapists need around 52 minutes less time with teletherapy, speech therapists need on average 61 minutes more time for teletherapy and physiotherapists need around 84 minutes less time per week with the teletherapy format. Moreover, adding the preparation and the follow-up time for the teletherapy, around 19 minutes for preparing and follow-up the tasks for synchronous units are needed and around 26 minutes for asynchronous ones, if new exercises need to be implemented into the REHA2030-system, otherwise only 10 minutes are needed. It should be emphasized that the exercises installed can be transferred/applied to other patients or can serve as templates, but that some time must be invested, or a longer period of use is necessary in order to have a large pool of exercises. The therapists stated that the system was user-friendly and only problems with transferring or uploading videos occurred and could be solved.

Considering the perspective of relatives, the travel time and the costs were also considered. As sometimes dependents drive with the patients to the therapy their travel time has to be considered too. Travel time was approx. 30 minutes. Including the costs calculated on the basis of the travel costs charged for the patients, the relatives could also save about 65 EUR per week (see calculation for patients). Additionally, in the survey it was stated that a reduction of stress due to scheduled dates for driving to the therapy was helpful.

The overall economic benefits were primarily discussed in the focus groups. First the relief of the health (care) system was discussed and resulted in the view that follow-up therapies might be reduced, but cannot be quantified. Since lifelong training is necessary for patients after a stroke, telerehabilitation might be a constant support. In addition, the possibility of synchronous and asynchronous training with one therapist allows more patients to receive rehabilitation at the same time. In a broader sense, this could also bridge the waiting time for rehabilitation. Regarding the transport costs, it can be said that if rescue transport companies (such as the Red Cross) are necessary for patient transport, these can be saved by teletherapy in any case. In Austria, one kilometer costs approx. 0.99 EUR[1], which could then be saved. The faster integration into the labor market could not be underlined in the survey, because it depends on the clinical picture.

The last benefit parameter was the ecological effect of saving CO^2. With reference to the maximum calculated journey of 25 kilometers (example of a patient), approx. 0.0018 tons of

[1] Information according to the Austrian Red Cross via email on July, 26th 2022.

CO^2 can be saved if this distance does not have to be covered by car (fossil fuel; calculated based on Foundation myclimate, n.d.:online).

Cost-Considerations

The costs were calculated per patient per therapy. The technical intervention costs consist of equipment and installation costs, as already described. Above this, the cost parameter includes on the one hand the tablets at 13.83 EUR (rental costs), the medical-therapeutic device PABLO® at 194.22 EUR, accessories for the tablets such as protective cases, and on the other hand personnel costs for the training of the therapists at 12.75 EUR and for the installation at 4.36 EUR. In total, this results in costs of 225.97 EUR. The next sub-indicator includes the operation costs like costs for the internet (18.66 EUR), the electricity costs for the use of the tablet computer (0.0132 EUR) and the PABLO® (0.0004 EUR). Furthermore, maintenance costs including the insurance of the medical-therapeutic device PABLO® (7.65 EUR), material costs for support (purchase costs at 11.20 EUR; ongoing costs at 45.03 EUR) as well as costs for the second level support (personnel costs; 78.23 EUR) are of relevance. In total, this makes around 160.78 EUR per therapy. In general, royalties should also be considered when developing and implementing such an application, but in this project no fees for the software or PABLO® incurred. So, the technical intervention costs amounted to 386.75 EUR. The second main indicator includes the costs for the therapists or clinic consisting of personnel costs at 498.05 EUR, the first level support, which was provided by the therapists (6.67 EUR) and insurance costs, whereas no additional occupational insurance was necessary in the course of the project. Summing up, the costs for therapists were 504.72 EUR. The total costs for a period of the average five weeks of rehabilitation and assuming that six patients can use the REHA2030 system as telerehabilitation in one year, amount to 891.47 EUR.

Additionally, the development costs were also calculated and amounted to 14,652.75 EUR for in-house development of the system and 23,000.00 EUR to third parties for development.

Lastly, the willingness to pay was asked. The three patients would be willing to pay between 40 EUR and 200 EUR for further use of the telerehabilitation application. The therapists said that this option makes more sense for freelance therapists, who would be willing to pay between 50 EUR and 400 EUR. Another suggestion would be that the social security pays 25 EUR per teletherapy unit to the clinics to finance the telerehabilitation equipment and the therapists can choose for whom and when the telerehabilitation can be used.

Discussion and Conclusion

In summary, telerehabilitation takes about ten minutes more time from the patient's point of view, but costs 65 EUR less due to the elimination of transport costs for the private car. Cost savings can be achieved primarily by reducing the number of journeys to therapies and even personnel costs. The costs per patient per therapy were around 892 EUR. 519.70 EUR could be saved compared to conventional therapy. But it should also be noted that many people already have a tablet computer and would be able to install the app or system, which might then reduce the costs for the patients. In general, costs may vary due to changes in time or location.

In addition to cost savings, positive effects on motivation should be emphasized and are also supported by the literature. As Milani et al. (2021), Richter et al. (2021), Cramer et al. (2019)

or Dodakian et al. (2017) have already pointed out in their studies, telerehabilitation as a new format can strengthen training motivation and willingness to train. Moreover, in some cases, the number of patients per therapist could be higher, which would allow more patients to receive rehabilitation or to be treated more quickly. This point is underlined above all by the time saved by physiotherapists and occupational therapists.

Limitations can be seen on the one hand, that no standardized test procedures (e.g. Fugl-Meyer Upper Extremity-Test, EuroQoL-5) were carried out. On the other hand, the sample size was limited and further research and studies should be made as the presented studies cited also show limitations in their sample size (e.g. Rozevink et al., 2021).

In conclusion, teletherapy might not replace on-site therapy, because some patients need on-site therapies (hands-on therapy or help) due to their individual and clinical picture, but telerehabilitation might be a positive additional service.

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