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D2.3 Report on results of the focus groups and semi-structured interviews with primary, secondary, and tertiary users (version 2)

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[1] L = Legal agreement, O = Other, P = Plan, PR = Prototype, R = Report, U = User scenario
[2] PU = Public, PP = Restricted to other programme participants (including the Commission Services), RE = Restricted to a group specified by the consortium (including the Commission Services), CO = Confidential, only for members of the consortium (including the Commission Services)

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Table of contents

Information

This document will be updated periodically in the future. Therefore, it is marked with the respective version number and the date of actualisation.

Introduction

This document is a deliverable of work package 2, summarising the methodology and results of the interviews with end users (primary, secondary, and tertiary). The lead partner of this work package is the Zurich University of the Arts (ZHdK). The document will be updated during the course of the project when necessary.

Aim and research question

Aim: Using a qualitative approach, we aimed to gain an in-depth knowledge and understanding of the previous experiences regarding training with technology, especially exergaming, and needs and expectations on an exergame training solution in the geriatric population by asking primary (patients), secondary (therapist and trainers), and tertiary end users (health insurance experts or similar).

Research question: What are the end-users' experiences, needs and expectations of an exergame training solution in the geriatric population?

Methods

Ethical approval

For RZM, an ethics application for the focus-group interviews was submitted to the ethics committee of the Medical University of Innsbruck and was approved on the 2.6.2021 (reference 1153/2021).

For RHF, an ethics request (Req-2021-00621) for the focus-group interviews was submitted to the ethics committee of Northwest- and Central Switzerland (EKNZ) by the research Department of the Reha Rheinfelden. The EKNZ informed us that the project does not fall under the scope of the Human Research Act. Therefore, an ethical approval was not necessary.

Interviewees' eligibility criteria

Using a convenience sampling, RHF and RZM recruited 24 primary end users, 18 secondary end users and nine tertiary end users.

Eligibility criteria for primary users:

Inclusion criteria	**Exclusion criteria**
● ≥ 65 years old ● cognitive status allowing them to understand the study procedures/content and give informed consent, ● able to walk with or without a walking aid for 10 metres or, if wheelchair-dependent, are able to sit in a wheelchair without arm and back rests	● joint contracture (shoulder, knee, hip) ● psychiatric diseases ● known terminal illness with a prognosis of less than 12 months or ● intense pain during movements (> 5 on the Visual Analogue Scale)

Secondary end users had a background in the therapeutic disciplines, medicine, psychology, or sport and training sciences. Tertiary end users are represented by individuals, who work in the health insurance sector or in national or international government or non-government health associations. The named organisations have in common that they can expect an increase in efficiency and effectiveness by using the end product, which helps saving costs in the medium and long term.

Interviewee recruitment

Primary and secondary end users were recruited at the rehabilitation centres RZM and RHF. Daily patient entry lists were screened for potential candidates, who were approached by members of the project team to inform about the study in written and oral form. After having provided initial consent, interviewees were screened based on the eligibility criteria. If all criteria were met an appointment for a focus group interview was scheduled. No therapy time was cancelled.

For the recruitment of secondary users, emails were sent to all potential therapists asking if they were interested in participating. After initial agreement, several tentative dates were offered via doodle to agree on a date for conducting the interviews.

Tertiary users were contacted via email. After agreement, a date for an individual online interview was scheduled.

Interview setting

RHF (primary and secondary end users): After having obtained informed consent from each interviewee, interviews were conducted as focus-group interviews in a quiet room with all interviewees sitting on a chair at a table. The room included a projector and a projection screen to display the interview presentation. All interviewees were offered something to drink. Short breaks were included when necessary.

Two members of the project group were present with one acting as a moderator and one as an observer, noting down all issues, disturbances or other comments.

All interviews were recorded with two redundant digital voice recording devices to avoid loss of data.

Interview guide

A presentation served as the interview guide for the semi-structured focus groups. The presentation was divided into an introduction (general attitude regarding movement and games/exergames, explaining exergames), main part (training and technology, training concepts, usability, harness preferences, data safety), and closing part (summary, final remarks).

Data collection and transcription

Demographic and disease related or professional data (age, profession, work experience, previous knowledge or experience with technology-assisted training) were collected for describing the interviewees in some detail, either by screening medical records of the primary end users, by direct questioning (RZM) of or using an online questionnaire (RHF) for the secondary and tertiary end users.

Recorded interview data were verbatim transcribed and anonymised based on the extended transcription rules by Dresing & Pehl (2018) by members of the project team or by a professional transcription service (www.transkripto.de, RHF). For transfer of the recorded interview transcripts, the company had to sign a non-disclosure agreement and the data were transferred through a Secure Sockets Layer computer network to ensure a secure communication.

Results

The interviews were conducted between August and September 2021 at RZM and between October and December 2021 at RHF. Focus groups at RZM included six primary end users (September 2021). No adverse events or other issues were recognised.
Table 1 provides an overview on all interviewees.

Table 1: Overview interviewees in Münster (A) and Rheinfelden (RHF).

	Rehabilitation Centre Münster	Reha Rheinfelden
Primary end users	n=12 ● Polyarthrosis, osteochondrosis, vertigo (n=2) ● Ischemic or hemorrhagic stroke (n=3) ● Parkinson's disease, with and without knee joint replacement, orthostatic hypotension (n=5) ● Multimorbidity, vertigo, diabetes (n=1) ● Lumbar spinal stenosis with hip flexor paresis (n=1)	n=12 ● Ischemic or hemorrhagic cerebrovascular insult (n=5) ● Suspected structural epilepsy (n=1) ● Multiple sclerosis (n=2) ● Tick-borne encephalitis (n=1) ● Knee implant and Parkinson's disease (n=1) ● Polytrauma (n=1) ● Acute lumboischialgia, radicular pain syndrome, spinal disc herniation (n=1)
Mean age	75.7 years	72.8 years
Secondary end users	n=10 - Physiotherapists n=4 - Sport scientists n=2 - Psychologists n=2 - Occupational therapists n=2	n=8 - Physiotherapists n=6 - Sport scientists n=2
Mean age	35.3 years	35.4 years
Mean work experience	7.9 years	10.3 years
Tertiary end users	n=5 - Health insurance n=3 - Governmental monitoring committee for the rights of people with disabilities n=1 - Pro Senectute Austria n=1	n=4 - Health insurance n=3 - National health innovation manager n=1

Focus groups of the primary end users at RZM

Focus group sessions

Two focus groups were conducted on the 07.09.2021 and the 14.09.2021 at the RZM including a total of 12 patients (6 patients in each focus group). Three researchers were present at the meeting: one interviewer, one field-notes taker and one observer.

Movement and games

The participants in the first focus group enjoy outdoor activities such as walking, hiking, gardening, walking, cross-country skiing and cycling. In the second focus group, limitations and motivational problems were identified. Here, participants fear not being able to exercise as a result of too little activity. Card games, memory and chess were indicated as popular games in both groups. Both groups stated that they would partly lack the social environment to achieve this.

Video games

The attitude towards video games is rather negative Three participants reported playing Tetris on a tablet or smartphone. One participant reported a video game that had overwhelmed and stressed her. One participant reported that she was interested in becoming familiar with a video game but no one of her younger relatives had time to explain the procedures. In summary, the experience and interest in video games can be classified as low for all participants.

Motivation for using an exergame

Various motivational factors were identified in both groups: fast and easy operation, as well as the distraction from the movement itself and any associated effort, and time by immersing oneself in another world. Participants rated opportunities for improvement, a progress check, and the opportunity for continuous feedback as very motivating. In the first focus group, participants reported that they can no longer perform hobbies they used to pursue, such as playing tennis. Group members considered it very motivating if they were given the opportunity for getting into contact with their previous hobbies again via an exergame. The second group emphasised that a social network was crucial for them, for example for exchanging information with others about this game opportunity or for being able to play in a group setting, either locally or anonymously over the internet. Furthermore, the motivational factor of different choices such as juggling and dancing was mentioned in this group.

Barriers to using an exergame

Several barriers for using an exergame were identified in both groups. An exergame that did not meet or seemed not to meet the needs of the participants and lacked progress monitoring were rated as demotivating by the participants. The lack of transferability into people’s everyday lives was also considered a barrier and demotivating. Furthermore, the patients regarded it questionable whether it was still possible to use an exergame for therapy with physical restrictions, for example a prosthesis. Using comprehensible and familiar spoken and written language was considered key; for example, participants strictly disapproved of the inclusion of

English terms. The participants reported that for them non-German instructions would be very demotivating.

Data privacy, data protection and security
Data privacy is very important to the participants. It is important for all participants that as few people as possible have access to the data. They would entrust their data to their treating therapists and doctors.

Focus of the therapy
In this category, patients could describe which area of rehabilitation they would like exergaming to address. The most frequent therapy suggestion was balance training, which was reported in nine patients. The second most important type was strength training, with eight votes from patients. This was followed by endurance training, gait training, and speech and writing training with two votes each. Rhythmic auditory stimulation training, mobility and cognitive training and respiratory therapy were also named as important types of therapy.

What the primary end users imagined for an exergame
First, participants believed that rhythmically cued movements represented exergaming. Furthermore, they suggested training of movement sequences, reaction skills, mental functions, balance and endurance training with feedback in a virtual environment for an exergame.

Patient safety
Safety is a very big concern for the patients. To ensure their safety, the patients desired a therapist or training specialist staying close to them at all times. Furthermore, they stated that a possibility to hold on to something/someone would be another relevant option for increasing their physical safety.

Group training
Group training is seen as positive by all participants because it is motivating and there is a sense of cohesion between people.

Responses to an exergame video
A video was shown to illustrate an exergame with different scenarios. During the focus group interviews, negative and positive reactions were recorded. All participants found the fall protection and the close-to-real environment and tasks very positive. Negative reactions of the participants comprised a fear of dizziness, which was expected to be triggered by an exergame, and a certain shakiness that was anticipated due to the many stimuli. Another negative reaction of the patients was the possible lack of variety with respect to the exercises and activities.

Preferences with respect to a safety harness system
Different safety harness systems were presented to the patients and questions asked as to safety and convenience aspects. Patients' preferred the system that seemed the safest. Overall, the focus on safety was mentioned five times and the focus on convenience three times.

Patients described that a harness should be easy to attach to the body, and preferably without help from a third person. The option of a safety button on the belt of the safety harness was presented to the patients. This safety button could be used to stop or pause the exergame; alternatively, the button could be used as a part of the game, e.g., to trigger the player's interaction with the game. Four out of twelve patients stated that they regarded the safety button as a simple stop button as essential, and a majority of patients reported they did not like it as part of the exergame.

Summary
The focus groups allowed new ideas to develop and many important aspects to be discussed. In summary, the three most important aspects mentioned by primary end users were safety, everyday relevance, and fitness improvement.

Focus groups of the secondary end users at RZM

Focus group sessions
Two focus groups were conducted on the 23.08.2021 and the 31.08.2021 at the RZM including a total of 10 physio- and occupational therapists, sports scientists and psychologists (5 therapists in each focus group). Three researchers were present at the meeting: one interviewer, one field-notes taker and one observer.

Therapy strategies and therapy backgrounds for patients at risk of falling
The first questions asked about the background and strategies of therapy for patients who are at risk of falling. All secondary end users agreed that balance and coordination training may maintain or increase independence in activities of daily living. They were in agreement with each other that this may improve patients' quality of life. Balance and coordination training was characterised by versatility and variety, which can be performed with various types of training equipment. Dual-task training was put forward as an example of another relevant therapy content in this population. For example, the ability to look to the front or side during walking can be trained without having to interrupt the walking activity. For the secondary end users, the transparency of the objectives in their communication with the patients and the meaningfulness of the individual exercises are paramount. For patients who are at risk of falling, the fear of a possible fall was identified as an important issue. The fear of falling can be specifically addressed in a safe exercise training setting, e.g., with the help of fall training. Furthermore, individual limits can be addressed in therapy, thereby improving self-perception and self-confidence in patients. The goals of such a training should be realistic, challenging, individual and adapted to the current health condition of the patient. Some of these goals are addressed with exercises that refer to the daily life of the individual.

Previous experience with exergames
With respect to previous experiences with exergames, different therapy devices were mentioned by the therapists. In both focus groups, the Lokomat© (Hocoma AG, Switzerland) was mentioned. This is a stationary exoskeleton for the lower extremities on a treadmill with body weight support. The experiences were described positively. Therapists described that the body

weight support would enable new movement dimensions and thus allow gaining new movement experiences in a safe environment. Furthermore, they emphasised that in this way, confidence in one's own abilities can be gained or enhanced. The potential was mentioned to carry out additional game-based activities with a patient via an external monitor. This option would increase the patients' motivation and engagement in the rehabilitation.

All secondary end users reported that they were familiar with the Armeo© (Hocoma AG, Switzerland). This is a robotic exoskeleton for the upper extremities, which aims to improve eye-hand coordination. In the first focus group, another sensor-based rehabilitation device was put forward, the Pablo© sensor device (Tyromotion GmbH, Austria). Pablo enables motion analysis and thereby supports an individualised therapy. In the second focus group, the secondary end users mentioned another sensor-based rehabilitation device, the TYMO© (Tyromotion GmbH, Austria), which can be used for static and dynamic motion assessment and application of individually targeted therapy. Furthermore, the Amadeo© (Tyromotion GmbH, Austria) was mentioned in the second focus group.

Based on the experience with technology- and game-based rehabilitation devices, there was an overall consensus between therapists on the increase in patients' training motivation associated with their use. This was attributed to patients receiving direct feedback on the amount and quality of the tasks and movements performed. It was considered very important by all involved therapists that the patient would not be overstrained or overburdened by very complex game scenarios. This overstraining could lead to rapid frustration. The effect of "getting out of everyday life" with certain game scenarios and environments was perceived as very rewarding, as novel experiences can be created.

Advantages and disadvantages of technology-based rehabilitation devices in general and exergames / the ExerCube or ExerG in specific

One of the biggest advantages of exergames reported in both groups is motivation, fun and engagement of the patients. The external focus is in the foreground and thus patients can be distracted from their worries, stress and anxieties of everyday life. New movements and ranges of motion can be made possible through the possible body weight support. New and unfamiliar experiences can have a very positive impact on the therapy experience. Another key aspect represents training of everyday tasks in a safe environment. The secondary end users considered a quick and individual adjustment of the therapy options another big advantage of technology-based rehabilitation devices.

Among the greatest disadvantages of technology-based rehabilitation devices that were identified was the hesitancy and scepticism towards new technologies in older persons and the possible associated overburdening. This could occur especially if an exergame was disconnected from everyday life and involved abstract gaming characters. Therapists reported concerns as to the possibility of stroke patients or patients with unilateral physical limitations receiving false feedback if the game design was not adapted to the individual health condition and situation. Furthermore, elderly patients who are at a high fall risk may require the use of assistive devices such as walking aids or orthoses, which might not have been adequately

taken account of in an everyday game. Secondary end users expressed concerns about a lack of proprioceptive feedback during exergaming without actual proprioceptive stimuli present, as compared to proprioceptive information gained during a walk across rocks. As a result, therapists were afraid that important stimuli could be lost. Another disadvantage was put forward that was related to the size of the ExerCube which requires a stationary setting. As a further disadvantage, the therapists mentioned the impossibility of a self-determined, independent exercise training in the Exercube in a home setting. They further identified another possible disadvantage that could be associated with a lengthy and complex hardware set-up or any necessary hard- or software adjustment to be done by the therapists. This could consume valuable therapy time and represent a barrier to the implementation of the exergame training. In addition, the therapists described that the short therapy sessions of 25 minutes in routine rehabilitation care could be a potential barrier to the implementation of the exergame. This could limit the full immersion into the exergaming world. Another disadvantage could be a reduced social interaction between therapist and patient as compared to conventional rehabilitation.

Desired effects of ExerG training

All secondary end users agreed that training with the ExerG should improve physical reaction time in patients. Other desirable effects were strength, endurance, coordination and balance improvements. Another important area for achieving effects were ‘dual tasks’ in everyday life. An improvement in the dual task capability would benefit patients in their everyday lives, for example when crossing a street or shopping. Furthermore, the therapists suggested that psychological function in general and concentration and attention in particular should be addressed by the ExerG training.

Exergame therapy concept

For the training set-up, the secondary end users suggested one to two training sessions per week, with a training duration of 30 to 60 minutes each, or three training sessions per week with a duration of 30 minutes each. These training dose parameters would depend on the varying degrees of difficulty of the training and the patient's health condition and endurance. The suggested training structure is based on the conventional individual treatment duration of 30 or 60 minutes. For enabling the longest possible ExerG training session duration, therapists mentioned the necessity of a quick and uncomplicated adjustment of the device itself including the fall prevention harness. In order to diversify the therapy setup and address the different therapy goals in individual patients, a range of different modular exercises and motor activities was regarded as crucial by the secondary end-users.

Regarding the user friendliness of the ExerG, it was explicitly stated by the secondary end users that the speed, volume and design need to be adapted to the older patient group. Entry into the training should start with low-threshold stimuli, which should be able to be increased slowly and progressively. The tasks should be clearly and concisely formulated and repetitions should be enabled as needed. For appropriate usability, there should also be a very good sound quality in terms of volume and the sound output device. Furthermore, graphics as close to everyday life as possible would be desirable. Ideally, possible impairments such as hemiplegia after a stroke could be detected by the sensors and the gameplay adjusted and thus, a specific and individual

training could be performed. Furthermore, an individual adaptability to the respective patient and, if necessary, to the respective clinical presentation would be desirable. Another important aspect would be the gradation of cognitive complexity of the game. It should also be possible to address degenerative concomitant diseases such as eye diseases by, for example, the possibility of setting high contrasts. There was a disagreement between secondary end users about the use of additional assistive devices during ExerG training. Some requested that the use of aids and thus the targeted training of stairs was enabled. Others responded that training without aids yet with the help of a safety harness would be preferable, in order to allow for operating at the limits with the patient. All secondary end users considered a button indispensable with which the patient can stop the game immediately.

Furthermore, the secondary end users were asked about their design suggestions. The ideas of the secondary end users comprised both exercises which are close to and relevant for everyday life, such as shopping, cooking or gardening, and exercises in a highly immersive, fictional environment which is far from usual problems and everyday life. Other suggestions were to incorporate a street view from Google maps to train spatial perception and orientation. Furthermore, an action-planning training was mentioned that could be incorporated into the ExerG training concept.

Safety hardware

For all secondary end users, patient safety aspects are paramount. These include a fall prevention device that can be moved and rotated in all directions in the form of a supporting device. As mentioned previously, all secondary end users considered a button indispensable with which the patient can stop the game immediately. Regarding the possible type and form of a safety harness, different models were favoured by the secondary end users. In the first focus group, a vest would be favoured over a waist belt, since a waist belt would rather lead to movement restrictions of the patient and thus impair free movement execution. Furthermore, a possible urinary catheter was mentioned as being potentially problematic. The second focus group viewed the vest as problematic, due to a possible compression of the trunk and an accompanying restriction of movement. In this group, secondary end users favoured support harnesses with four straps, with two in the front and two in the back. This was thought to provide maximum security while maximising flexibility. The harness could function much like a seatbelt in a car. During slow movements, maximum flexibility would be provided and during fast, jerky movements, the system would stop. Furthermore, this would allow for a possibly necessary body weight support. A flexible suspension was also regarded as important, together with the absence of any twisting or obstruction during the exergaming session. As another important safety aspect, the possibility for the patient to sit during breaks was put forward.

Data privacy

For the secondary end users, data protection is a very important issue. The data should be available to the respective institution and enable interdisciplinary collaboration, but the data should not leave the institution and should be as secure as possible. A possible training app was discussed controversially. Some therapists considered an app superfluous, since a therapist would be available for the entire duration of the therapy. Others regarded an app as a

useful add-on, which could be used across disciplines because all data would be available immediately. Another advantage would be that the therapist could use the app to monitor the training session without leaving the patient alone while using the notebook.

Patients' willingness and motivation to train
For the secondary end users, the meaningfulness of the therapy intervention is a first priority. This should be communicated to the patients in an understandable way. It is possible that a fear of the unknown or an aversion to the novel device could occur. However, the secondary end users were confident that the game character could take patients on board, regardless of their age. Therapists suggested that motivation could be increased by displaying progress. Furthermore, the experience at the patient's individual limits would be another motivational factor. By immersing and focusing in a created world, new limits could possibly be set or new seemingly impossible movements could be realised and practised.

Group therapy
Regarding a possible group setting with the ExerG, the secondary end users were in disagreement. Some reported that a possible disadvantage of a group setting could be permanent comparisons among patients, which could lead to demotivation and frustration. Due to different diseases, a strong heterogeneity could occur in the group. Due to the differences in performance, patients could be over- or underchallenged. Others reported that an advantage could be the resulting group dynamics, which could increase the motivation and fun in the patients.

Summary
In summary, the three most important aspects for secondary end users are safety, intuitive usability, and the option to customise the therapy to the individual patient.

Focus groups of the tertiary end-user at RZM

Five individual online interviews were conducted. Interviewees were senior representatives and team leaders of health insurance companies, Pro Senectute Austria and the governmental Monitoring Committee for the rights of people with disabilities.

Experience with exergames
The experience with exergames was mixed in the tertiary end users. In some cases, no experience was available. Some had experience in the private environment in the form of a Wii or a Playstation. Furthermore, experience was gathered at trade fairs. One tertiary end user reported to have gained their experience in a rehabilitation facility in Vienna, where a relative after a stroke underwent therapy sessions. The end users' statements showed a predominantly positive stance towards exergaming. Some reported that exergaming was associated with increased motivation and fun. It was perceived as a distraction and immersion in another world with a positive 'side effect' of exercise. A tertiary end user already had experience in working in a project with a similar system, in which arm movements were used to operate a shopping

scale, clear out a shopping cart, or avoid obstacles. This tertiary end user described that they could gain some experience with gamification.

Implementation of new therapies

When implementing new therapies, a tertiary end user reported, it is essential that all stakeholders were considered, and that there exists an effective communication between groups regarding what is meaningful and what the goals of the therapy are. This could make a difference for the training effect.

Therapy setting

For the implementation of exergaming as a new form of therapy, one of the tertiary end users suggested the rehabilitation setting as a factor. For a nursing home, the sociability and group experiences were in the foreground and not the rehabilitation success. Another tertiary end user would find an option for residents of a nursing home essential. This could address different biographies, such as professional careers or leisure activities. For people with dementia, emotions and images would play a major role. Another tertiary end user described the possibility of incorporating exergaming into telerehabilitation as a support or as an add-on in a rehabilitation. However, it would not be able to replace the competence of a physiotherapist in a one-to-one or group setting. It was very important to achieve the rehabilitation goals. It would be counterproductive if every patient in a group sat alone in front of a laptop and the therapist made little contribution. For a possible integration into telerehabilitation, professional requirements and interfaces would then have to be considered. A tertiary end user assumed that in the rehabilitation setting it would be difficult to find suitable premises, due to the size of the Exercube.

A possible disadvantage of exergaming could be the primary focus only on isolated functional exercises. The rehabilitation was restructured to a participation-oriented rehabilitation. The risk here would be that again only the functions were trained and the relevant perspective of the participation-oriented rehabilitation would be lost.

Therapy sessions

A tertiary end user could envision exergaming becoming an integral part of therapy and training routines. Exergaming, they said, is a very interesting approach to combined physical and cognitive training for patients. The combination of the two factors seems very important, this end user mentioned, as the two areas belong together and should be promoted together. Technical options could not replace personal therapy in the future. It would be a combination and would be used as an add-on option. Furthermore, it would be important to elaborate and present the specific additional benefit of exergaming in comparison to the therapy performed so far. A tertiary end user expressed a certain scepticism regarding exergames in a rehabilitation setting. Exergaming is an individual training for the older generation, the end user stated. Exergaming should hence offer different scenarios and possibilities and not become boring. The (lack of) affinity towards computer games in the older population was perceived as a challenge.

Preventive therapy
A tertiary end user spoke in favour of preventive fall therapy. Preventive fall therapy would be very helpful, as susceptibility to falls is present after a certain age, which could prevent secondary diseases.

Catalogue of health services
All tertiary end users considered the proof of efficacy of any type of therapy essential for inclusion in the catalogue of health services. For a therapy to be included in the catalogue of health services, proof of effectiveness is a requirement. Furthermore, it must be precisely defined for what insured persons the type of training is effective. Training for fall prevention could be difficult, since a diagnosis would have to be available for the indication of a therapy. Add-on therapies are more expensive than the currently used "state of the art" therapies. Users should then be provided with the option to choose whether to pay for this add-on therapy themselves.

Funding
For integration into a rehabilitation programme, it would have to be a medical device and all post-evaluation phases would have to be completed. This would then allow a possible assumption of costs to be negotiated. Tertiary end users agreed that there must be measurable effects for possible funding. They stated that the acquisition costs are an important aspect for the respective rehabilitation institutions.

App
The first tertiary end user would consider a therapy app useful, in which the training data are stored. However, the app must be easy to use for the insured person. One tertiary end user would find longer-term monitoring for the respective patients exciting, in which the blood pressure curve and other medical data could be read. If the app could also interpret the data, the risk of misinterpretation would have to be excluded here.

One tertiary end user would see the possibility of an app as very practical. They emphasised the possibility that it would be very important for all professions to have access to it in-house. Another tertiary end user was very sceptical about developing an app; this user would not want to track their data and progress via an app. They find it demotivating and want to feel the success themselves.

Advantages of a training app, which would be available for both the patient themselves and the interdisciplinary rehabilitation team, would be its potential integration with other devices. For example, it could be connected to a training watch. This would allow the patient to track their heart rate etc., and all those involved would receive information or feedback on any critical values.

Group therapy
One tertiary end user could imagine exergaming very well in a group setting, especially with regard to interactive elements and music. The music would be an essential aspect, as its effects can still resonate in people with advanced dementia or with advanced Parkinson's disease.

Use scenarios
One tertiary end user would find different possibilities in nature very enriching, for example, that stones could be lifted or that a sand castle could be built. Playful and ‘discovery’-oriented components would be essential. Furthermore, a fictional world would be very exciting compared to everyday activities such as shopping. Another tertiary end user suggested a shaky and wobbly suspension bridge for balance training. Another tertiary end user described the relevance of the holistic nature of everyday actions. If shopping at the supermarket were taken up in exergaming, this implied a variety of everyday-related actions. These would be, for example, in a patient with stroke: being able to get out of bed alone, being able to put on socks and shoes alone, and being able to climb stairs or use a handrail. Another idea would be to simulate shovelling snow in a snowy landscape. However, an actual shovel would be desirable here. Movement without an actual functional object would be quite inappropriate. Another tertiary end user emphasised the importance of functionality in everyday rehabilitation. The biggest goal in a rehabilitation facility would be to make patients fit again to be able to re-enter the workforce or for the patients to be able to manage their daily lives independently. For this purpose, a selection of different occupations would be desirable, so that these could be specifically and specifically practised.

Summary
In summary, the three most important aspects of tertiary end users are the evidence of the effectiveness of the ExerG intervention, funding, and functionality for daily rehabilitation.

Focus groups of the primary end-users at RHF

In total, four focus groups with three primary end users each were conducted (01.10.2021, 13.10.21, 20.10.21, 3.11.21) with durations between 1h12min and 1h27min (1:11:05, 1:27:15, 1:16:46, 1:15:51).

Introduction questions on activities, games and videogames
Interviewees were active in the context of their home environment and activities of daily living (home work, climbing stairs, hoovering, gardening, grocery shopping, to go by bicycle, go for a walk). All participants liked to go for a walk (forest) or mentioned being active, e.g., in a senior gymnastic group, or go hiking.

To play a game or a video game is less important in their daily lives, because they did not grow up with it. They preferred “real” games (e.g., chess). Playing video games would not be appropriate for their age. Some patients mentioned some experience with videogames (e.g., playing Wii with grandchildren) and they recognised the competitive character (training without recognising it as a training). Others did not have experience with video games.

Playing a game was often associated with playing with their grandchildren or playing with friends in the afternoon (table tennis, cards). Some participants preferred to interact with the natural environment and other people rather than playing video games. However, some patients mentioned playing games on their smartphone or laptop (e.g., solitaire, scrabble, crosswords).

One patient reacted very negatively and mentioned that videogames would lead to stupidity and destroy the familiarity, because every family member would play on their own. However, patients mentioned that reactivity could be trained with videogames and it would be a good start to play an already analog game as a videogame with a person that explains the video game version.

Own position and experiences with exergames so far

Patients mainly did not have experience with exergames before they were inpatients in the clinic. In the clinic, most patients got to know some devices, e.g., DD System Legpress, Dividat, Lokomat, Armeo Spring, Motomed, Andago or the reDance. Some have already used the Wii video game at home with their grandchildren.

Most participants were interested and open to use exergames or technology-assisted training devices. However, they had some reservations regarding exergames and trying out new technologies. Participants worried about being overwhelmed by exergames at the beginning and pointed out that they would need some time and help to get used to the exergames. Patients believed that exergames might have a big potential in the future and that technology-assisted training would become more available. For the patients, it seemed to be important to engage with this expected development.

Advantages of exergames:

- individual adaptability of exergames to patients' experience and capabilities
- training of different movements and the reactivity
- monitoring of therapy progress
- the provided security measurements of many devices (handrail, safety harness, etc.)

Technology and usability of exergames

Not all patients had experience with technology-assisted training. In general, patients are open and motivated to train with such devices during their inpatient stay if they recognised improvements with their training or if they received feedback on improvements by the therapists. Patients mentioned they would stop the device-based training if it is not interesting enough or if no functional and/or cognitive improvements can be observed. Most patients rarely used technology-based devices during their daily life and some fear a desocialization with the increased usage of technology-based devices in daily life.

Advantages of technology-based training:

- repetitive training due to identical and especially precise repetitions of movements
- individual adaptability of the exergames to the users needs and abilities

- the holistic training and therefore, the simultaneous training of body and mind
- diversified and playful training and that the games are often fun to play and distract the patients from the efforts made

Disadvantages and barriers to use technology-based training:

- possible overload (colours, design, sound, too many inputs in general, etc.)
- high effort needed to complete exergames
- absence or reduction of social interactions with the therapist
- the need to first get used to the video games and the device
- perceived high space requirements
- time needed to configure the devices
- potential technical difficulties

In general, a good introduction to a new device, general support and supervision during training, individual adjustments during the course of the therapy, and visualisation of progress would encourage the patients to use exergames more often. Moreover, patients expressed a need for safety measures, which must be given at all times during training in order to feel safe. One patient expressed that an outpatient service would probably also facilitate access to training with exergames.

Data privacy

In general, participants had no or little concerns about data protection. An anonymous storage of the data within the respective institution is preferred and the training data should also be viewed by the professionals involved (physician, physiotherapist, etc.) in order to provide feedback or document progress. The patients approved transparency and communication between the relevant specialists in order to provide the best therapy, training and recovery possible. Some patients mentioned that the collected data could potentially be used by the device or software manufacturer for further development and improvements.

Training aspects

Patients mainly undergo therapy in the form of physiotherapy and occupational therapy. Fitness training and self-training are also included. Main therapy goals that were mentioned included increased stability, balance and mobility, walking and gait safety, increased muscle function, improved fine motor skills, and regaining independence in activities of daily living. In general, all patients focused on increasing their independence in everyday life. Some patients mentioned that the improvement of cognitive functions is also a goal that they pursue.

Patients believed that some of their goals, e.g., balance, can be trained with new technologies and exergames, but some cannot (e.g., fine motor skills, speech training). In general, technology-assisted therapy and training should be integrated as an additional therapy next to conventional physiotherapy. With this approach, a greater benefit could probably be achieved. For fine motor skills, patients had difficulty imagining how exergames could help. Some patients can imagine exergames to help improve their reaction time.

An important aspect during therapy and training is the aspect of safety. Patients emphasised that it is very important to feel safe during every training and therapy and that falls should be prevented. Some patients reported to receive the feeling of being secure by the instructions, feedback, and support by the therapists. The feeling of safety allowed better progression during therapy and training.

Patients reported that their motivation depends on the daily condition and the contents of the therapies. Usually the morning routine is crucial and good quality of care increases the motivation in training sessions. In general, patients were motivated for therapies and training, where they perceive a benefit and an improvement. Exergames could be more motivating than conventional training, if there is a certain functionality and transfer to everyday situations. Positive and motivating aspects about exergames were playfulness and that exergames can distract the patients from the efforts they have to make during the training. Moreover, it is perceived as motivational that physical and mental functions can be trained at the same time. In general, the patients prefer conventional therapies over technology-assisted training.

Social aspects

All patients who were asked about therapy settings preferred an individual therapy setting as they perceive it as more beneficial than group therapy settings. They believe that individual therapies can better achieve individual support and feedback from the therapist, better focus on the patient's needs, and result in more progress. During group therapies, there are patients with different backgrounds and physical and cognitive functions, which makes it difficult to create a suitable setting where every patient is challenged adequately. Nevertheless, the communication with other participants during group therapies, each other’s support (getting “pulled along” by others) and getting to know other patients were considered positive. In a group, tasks that would be boring alone (e.g.,balance training) could become interesting and motivating due to the interactions with other participants. In a group, the participants can motivate each other; however, the opposite outcome is also possible and participants become demotivated when they are in direct comparison to others, and when the therapists cannot focus on all participants and therefore cannot provide detailed feedback for everyone. Overall, group therapies can be motivating and bring advantages, however they were seen as less beneficial than individual therapy settings.

Communication with the therapist was given a high priority. Trust and a good relationship with the therapist are judged to be key factors in the success of therapy. Empathy and responsiveness to the individual is also important to patients to achieve the best outcome possible. For the patients, it is important to always have the same therapists in order to receive individually customised therapy, and so that the therapists can get to know the patients and their strengths, weaknesses, and status/progress very well. Only one participant preferred to train completely alone as much as possible.

Exergaming concepts

In general, participants were positive about the presented videos and pictures of the ExerCube. Based on the pictures and videos of the original version of the ExerCube (not designed for older adults), patients felt unsafe about the difficulty level of the system for elderly persons and they had problems envisioning the workout with their personal limitations and concerns about possibly being overwhelmed. The current ExerCube version is seen as a sports training device rather than a therapy device.

In contrast, the exemplary videos of the new software met with more approval from the patients and it was more imaginable for the participants to train with a similar software. An integration of this training device is conceivable in general, but needs to be profoundly tested in advance and clear benefits from this training must be made evident. Overall, patients preferred a real-life gaming environment, e.g., in a forest or supermarket, over a virtual and gamified environment, e.g., Sphery racer. A diversified training that allows each training session to be adapted and varied would be very appealing to the patients.

Patients rated the combinational training of the body and brain very positively and liked the idea of holistic training. Furthermore, it is important for them to understand the games' and exercises' meaning and possible transfer into their daily life. They would prefer to train daily living (e.g., gardening, household tasks) and leisure activities (e.g., sportive activities) in a safe environment in order to regain more self-confidence and independence. Moreover, training of the reaction time, mobility, endurance, coordination, agility, strength, and training of cognitive functions were named to be important training content. It is crucial for the patients that meaningful, clearly defined/explained and useful tasks and exercises are included so that a clear benefit for daily life can be seen. During the training, patients would like to receive sensory (e.g., vibrations on the trackers) and visual feedback (e.g., picking a product from a shelf in a supermarket and it then can be seen in the shopping cart) from the training system, so that it is clear that a certain exercise is completed or correct.

Patients find it crucial that games and exercises are adaptable to different difficulty levels so that patients with various diagnoses can train with the ExerG system and everyone could receive an individual training plan. An adaptable training system would be motivating.

If benefits and therapy progress can be perceived with such a system, patients would like to test the ExerG. A good general instruction to the system and a close support during the first few sessions is of great importance. Patients mentioned that they would need some time to get used to and get comfortable with this new training device.

Patients proposed a therapy duration of 15 to a maximum of 30 minutes per session. They would train approximately 1-3x/week in the Cube. However, these aspects depend on the finished software version and on their individual restrictions and diagnoses.

Patients emphasised that they would need to test the system themselves before they could provide definite answers to the training aspects and concepts of the ExerG system.

Safety and ergonomics

A reliable fall protection inside the ExerCube is a must for most patients in order to feel safe and confident during the training. The therapist should provide safety support, and instruct and control movement execution during the training. The patients think that a therapist cannot be fully replaced.

The patients would put on a safety harness themselves if possible, but they prefer the help and above all the inspection of a therapist (e.g., to correct adjustment). No final opinion on wearing comfort and which safety harness they would prefer was possible (important: upper and lower body should be secured). Some patients would like to have an adaptable harness where the upper body part could be detached from the lower body part so that an individual support can be provided. A safety harness should provide the best safety possible and also the greatest freedom of movement possible. It is of great importance that the time needed to put on and take off the harness is as short as possible in order to not lose too much therapy time.

Additional functions of the harness (e.g., buttons) were difficult to imagine and were evaluated neither as positive nor negative. It could have benefits (e.g., add more difficulty, make the setting more realistic) but it could also lead to distraction during the training. One patient could imagine an additional stimulation of nerves or muscles during the training or unforeseeable actions of the system (e.g., swaying of the harness) in order to simulate unpredictable events in daily life. Overall, any additional functions should also be adaptable concerning the difficulty level and it should be possible to turn them off at any time.

Closing remarks

Patients found the ExerGetic project interesting and were happy to add something to the development of the new device. They could imagine that the ExerCube could be useful for any impairments but activities of daily life must be simulated in a safe and realistic environment. A clear benefit and therapy progress must be given by the system so that it can be successfully implemented. Patients would like to be able to turn off any additional functions when training in the cube and an adaptability of such functions to various difficulty levels should be possible. Safety in general is a crucial aspect for patients in order to feel confident during a training session. Therefore, a reliable security harness with the greatest freedom of movement must be provided. Additionally, patients cannot imagine training completely on their own and therefore would like to have a therapist at their side (feedback on the movement execution, feeling of safety and control).

An individual adaptability of the system to each patient is of great importance to the patients. It was difficult for the participants to estimate whether the benefits of the new device would outweigh the costs. They could not fully envision how the device would be applicable within the daily training routine and would like to test the device by themselves to get a better picture of this new concept.

Focus groups of the secondary end-users at RHF

In total, two focus groups with a total of eight secondary end users were conducted (on 04.10.2021 and 13.10.2021) and took 1h 32min 34sec and 1h 41min 15sec, respectively.

Opening questions on training & technologies

A targeted training for balance improvement and improvement of cognitive functions is considered to be very important. Cognitive and physical training must be adapted to each other to avoid overstraining. In general, exercises that can be integrated well into everyday life should be part of the therapy plan and must be individually adapted to each patient. Other important content of therapies and training that were named are sensory therapy (e.g., foot sensory therapy), optokinetics, cardiovascular training, and dual tasks. Overall, the prevention of falls and the training of according exercises, cognitive training and the training of dual-tasks were of high importance.

Almost all therapists already have experience with technology-assisted therapy devices like the Dividat, ArmeoSpring, Lokomat, Myro, Float, Erigo, etc. Therapists emphasised that a good and individual general introduction to a new technology-based device is crucial for the patients to get motivated and confident to train with the appropriate device and that they are not overwhelmed, especially elderly patients. All inputs in the exergame (e.g., visual or auditory inputs) should be minimised and adaptable individually. Exercises and devices must have a clear meaning and purpose and a transfer into activities of daily living should be possible.

The playful character of exergames was important; you can also appeal to many patients with very simple game ideas. However, exergames and technology-assisted devices were seen as supplementary therapy and cannot replace conventional therapies.

Characteristics primary end users

Therapists emphasised the importance of including common characteristics of patients over the age of 65 years into the development process. Elderly patients often have multifactorial impairments, e.g., auditory, visual, optokinetic, coordinative or cognitive limitations. A device therefore must be individually adaptable to patients with different impairments and limitations. An integration of haptic, tactile and visual feedback into the system would be very helpful for the users. Moreover, elderly patients often feel unsafe and therefore, a reliable security system must be provided. An overstimulation of the patients by too many inputs must be avoided. Overall, a training system must be very adaptable in order to successfully address the target patient group and therefore, a wide range of requirements must be covered. The system must be easy to use and exercises and games must be straightforward with a clear training purpose.

Exergaming: attitude and previous experience

The therapists perceive the use of exergames and technology-based devices as a good supplementary therapy next to other conventional therapies and they see a possibility of home-based training with such systems. Therapists mostly had positive experiences with exergames and technology-assisted devices and many patients enjoyed playing games and receiving diversified therapies. Such training systems often distract patients from the therapy itself so that they do not focus on their effort as much as during conventional therapies.

The therapists see a great advantage of exergames in the fact that the patients can train independently and the therapists then have time to focus on the execution of the movement, can provide support and feedback, and can take on an observer role. The combination of cognitive and physical exercises that can be achieved in modern training devices and exergames is highly valued by therapists. Therapists see great potential in the technology as great progress was made during the last few years and therefore, more specific and adaptable therapy is possible.

Technology and usability of exergames

Therapists emphasised the importance of a good general introduction to a new device for the patients, and a step-by-step introduction in order not to overwhelm the patients. The attitude of the therapists to the devices is crucial as patients would notice if a therapist is not convinced by a device. In general, the attitude of elderly patients towards new technology is often sceptical in the beginning but becomes more positive when patients become used to the device and see the purpose of it.

Obstacles of using new therapeutic devices were:

- Potentially complicated software, a long setup time, harnesses with too many straps and clippers to put on, and general technical bugs/difficulties with the harness and software
- the need of a certain infrastructure for optimal usage, which is not always given in a clinic
- costs/budget, when considering the purchase of new devices
- bad customer support

Motivational and encouraging aspects were mentioned:

- good user-friendly device, good usability, quick setup, straightforward software, flawless functioning of the device (no errors all the time)
- generation of a therapy report by the device
- (objective) assessments easily and quickly and therefore many data can be collected about the motor/cognitive functions of the patients
- if the game itself is distracting patients from their efforts, is fun to do and has a variability (different games/difficulties, etc.),
- competitive games among patients can be motivating

Exercises must be easy to understand so that therapists do not have to guide the therapy session but can rather take on an observational role and are able to give direct feedback to patients and control the movement execution. With this setup, tactile feedback from the therapists can be given more easily.

Concerning safety precautions, therapists emphasised that an emergency stop is the most important thing in technical devices as it must always be possible to remove a patient quickly and safely from a device at any time. The measurement of vital parameters is also helpful (e.g., heart rate) so that the patient can be tracked and therapists can estimate the condition of the patient at any time. The safety precautions of the system must be reliable and data protection must be ensured.

Data safety

Therapists view patient training data as highly sensitive. The therapists are critical of a cloud solution for data storage or the use of data for marketing purposes by the manufacturer. The persons in charge (therapists and physicians) however should have access and should

exchange results with other therapists/physicians for the benefit and training progress of the patient. Data should remain in the clinic or institution.

The therapists were unsure about the usefulness of an additional app. They could imagine a well presented and understandable monitoring, but an interpretation of the therapy data by a therapist or physician is necessary. The therapists do not want to rely on the patients' own responsibility to engage with the app and monitor progress. Some therapists could imagine benefits from an additional app and the possibility of the patients to train on their own.

Therapists want a possibility to train anonymously without imputation of any private data. Data should stay inside the clinic and not be automatically transferred to the manufacturer and each patient should be able to decide who can see their training data and how it should be stored.

Training aspects

Exercises should:

- be trainable e.g., proactive and reactive exercises, strength training, endurance training, coordinative training, combined movements, dual tasks and the combined training of cognitive and motor functions
- include visual and/or haptic feedback
- be individually adaptable to each patient and any additional features must be able to be adapted, activated and deactivated
- simulate activities of daily living in order to provide a high transferability into the daily life with various levels of difficulty
- include spatial and large movements and the training of transfers (e.g., standing up/sitting down)

When asked what an exergame could cover that conventional therapy cannot, therapists could not think of anything specific. However, they liked the fact that training with exergames is self-explanatory due to the playfulness, so that the patient has to think for themselves and become creative in order to control something. At best, the therapist then has to give fewer instructions than in conventional therapy.

The therapists classify the motivation of their patients mostly as intrinsic. However, this varies depending on the patient. They can imagine increasing motivation through exergames. Motivators are the fun factor, feedback on performance and individual challenges. Motivation could be reduced by pain during training, no progress or an exergame that is too easy or too difficult.

Social aspects

The therapists emphasised that a group dynamic can have a motivating effect on patients as they can exchange with others and motivate each other by sharing successes and failures. This also allows them to learn from each other, laugh together, and interact socially. However, through social comparison, some participants can also withdraw and no longer actively participate in therapy. In addition, the attention span, character, and training level of patients varies, so less individual attention can be paid to them in the group setting.

All therapists rate the interaction with the patients as highly important. Open and honest communication is the be-all and end-all. Successful therapy is only possible when trust is established between therapist and patient, and when patients are met at eye level and therapists share their knowledge, listen to patients, and take them seriously.

Exergame concepts

In general, the therapists liked the presented pictures and videos of tasks related to everyday life (supermarket). Other tasks (e.g., snow landscape) were seen as less convincing as no clear purpose could be defined of these exercises. In general, a realistic game setting is preferred in the sense of presenting tasks of daily living.

The therapists missed feedback from the game, e.g., tactile or haptic feedback (like vibration when you touch something, etc.) and also visual feedback. There should be a reaction from the system to tasks that are completed or not executed correctly. A combined visual and tactile feedback would be optimal.

The current sports version of the ExerCube was very well received because it combines cognition with movements. Something like this would be very good in a simpler setting as well where controlled movements need to be performed.

The group cannot imagine the system working very well in a rehab setting at the moment. For them it is clear that the system was created for sports and there it is certainly very good. It is clear that it is still a prototype for therapeutic purposes. Implementability was considered good at the moment, but there would have to be feedback from the device. However, the concept of the adapted ExerCube software was well received, it would just have to be ‘polished’. With patients, less is often more, so rather provide less input (visual, auditory, etc.) from the device so that patients are not overwhelmed.
Therapists can imagine training spatial movements, situations relevant to everyday life that are useful for the patient as well as cognitive exercises. In general, instructions need to be clear and a purpose of each exercise/game must be provided in order to guarantee a transfer into the daily life of patients. Therapists would have their patients train in the ExerG for 10 to 15 min, with a maximum of 20-30 min. It should be used as an adjunct to conventional therapy. The frequency could be adjusted individually, probably about 2-3x per week.

Safety and ergonomics

Mentioned aspects of a safety device to prevent falling:

- Easy and fast applicable to save therapy time.
- Patients should feel safe during the training.

Mentioned harness solutions for safety and comfort:

- Not just a vest or bungee rope (see figure 1, 4, and 5 below) - both options are not safe if a fall occurs; trunk and legs should be kept safe because of the individuals’ age.
- A safety device/harness that provides stability to the anterior and posterior (trunk) is important.

- Harness solutions including leg straps (Figures 2 and 3 above) were preferred. Figure 3 is even more preferred because of the 4-point-support. That should help to increase wearing comfort because no soft parts will be restricted.
- Therapists could not decide on the best solution. It depends on the severity of the patients' impairment.
- Click closures would be appreciated.

Additional desired functionality (e.g., buttons) included:

- Features for tactile inputs would be good, e.g., vibrations on the hip to indicate to move the hip forward. This would be an advantage compared to other exergame solutions - however, the integration in the game seems difficult,
- 4D-input and other inputs seemed to be problematic because that might lead to overload, e.g., simulation of wind or a ship. If such stimuli were added, they should be specific and realistic, e.g., integrated in a paragliding game.
- Only a minimal body weight support should be possible (max. 10 kg) to keep movements as normal as possible.
- The individual should be able to independently solve movement tasks as normally as possible while wearing the harness.

For the therapist during training, they stated the following:

- The therapist should take on only a passive role, e.g., as a coach, but with important inputs (verbally, tactile) to ensure movement quality.
- Games should run smoothly so that therapists could concentrate on the patient and their safety and progress.
- Therapists feel more comfortable if they can help the patient to put on the fall prevention device; checking for the correct fitting of the fall prevention device should be mandatory.
-

Final comments and suggestions regarding the training system:

- The system should be easy to operate and entry options should be minimised ('less is more', 'keep it simple').
- Optokinetic training options would massively increase the usability of the system. The training requirements would already be available in the system.

- Environments stimulating situations of activities of daily living in a simple way would be helpful for training in a safe environment.
- Obstacles on the floor would be good for balance training.
- Early test opportunities for therapists were recommended.

Final comments and suggestions regarding the interview:

- Interview structure could be improved. The ExerCube should be presented at the beginning to have more time for discussion for the specific device and in general.

Online interviews of the tertiary end users at RHF

In total, three online interviews with between one and two tertiary end users were conducted (one on 20.12.21, two on 22.12.2021), and took between 40min16sec and 54min15sec (00:54:15, 00:40:16, 00:50:07).

Opening questions on training and technology

Interviewees already had experience with new technologies and were involved in pilot projects (e.g., with Hocoma) that included exergames or technology-assisted training during the rehabilitation process. Furthermore, they knew several rehabilitation clinics in Switzerland and therefore, several technology-assisted training devices e.g., Armeo Spring, Lokomat, Dividat, ExerCube etc.

Advantages: The insurance representatives gained the impression that training with exergames might be more exciting and interesting also for older patients. Exergames and training with technology were very positively evaluated. It is anticipated that they provide motivation for training, and offer options to objectively evaluate training and progress.

Generally, interviewees showed a very positive attitude regarding technology in rehabilitation due to self-experience, financial support during device development, and its high potential in the future, e.g., virtual reality, hybrid training, and exergames in clinic or at home. Unfortunately, evaluations and clinical trials for usability, efficacy/impact of new technologies/exergames are lacking.

Disadvantages: The use of exergames or technology in general at home was criticised. To train at home on your own cannot be controlled and the handling of the technology device at home might be too difficult. Further, technology is costly and not affordable for everyone. At the moment, it is a special offer in clinical routine and cannot be reimbursed.

Most important is the problem-free implementation of the devices that includes an easy and fast setup with the patient.

Training aspects

Training and usability might be very individual and need to be adapted to the patients and have an added value for interested and motivated patients. With the help of technology/exergames data can be analysed in a more objective way and therefore, show the patients their progress

independent from a therapist. Adding the technology/exergames to the patients' schedule may increase the number of repetitions of exercises and training intensity. Furthermore, technology/exergames might help to carry out movements that are not liked by the patients but necessary for the rehab progress.

Insurance representatives cannot answer the questions regarding the possible adoptability of the devices. One suggested to use technology/exergames to train back muscles or to use technology/exergames for patients, who have to stay in bed for a longer period of time, or who are at a very early rehabilitation stage. However, not all patients may be suitable for training with technology/exergames. It depends on the cognitive and physical potential of the patients. There might be situations when technology/exergames are not appropriate. Technology/exergames cannot replace individual therapy with a therapist and they have to be supervised by therapists to execute correct movements and avoid wrong movements.

It might be possible to save infrastructure by using technology/exergames and therefore creating a virtual environment within a normal therapy room.

Technology and usability

Regarding financial support/reimbursement of training with technology/exergames one has to distinguish between an individual's basic health insurance and an individual's supplemental health insurance. Therefore, it is important to achieve target parameters with a new device in a pilot project, e.g., reduced inpatient stay, greater progress compared to conventional therapy in performing activities of daily living, being more independent, or that a wider range of patients can use the new device.

The benefit of the Exercube (technology/exergames) is most important and should be documented by a cost-benefit analysis. The benefit should be maximised compared to the necessary costs. The training concept has to show a clear benefit for all involved partners (insurance, clinic). A private use of technology/exergames seems not reasonable because the international competition is already very high. In general, the benefit and the function of the technology/exergames has to be evaluated, as well as its field of operation.

Interviewees of both insurances would be very open to support a pilot project including patients. However, an efficient cooperation and coordination among several partners would be desired (clinics, therapists, insurances, companies).

Data safety

There are legal and ethical aspects. Most importantly, patients have to provide consent that their data can be analysed.

For testing purposes of the ExerCube, several key performance indicators should be evaluated to demonstrate therapy/training progress. The insurance itself is not interested in the training data of the patients. In a (pilot) project, it would be important to see on what parameters the progress can be measured or not. Otherwise, therapists, physicians, and project members should have access to the training data. The use of a mobile application to collect and analyse training data in a clinical setting seems reasonable and has benefits, e.g., analysing real training

data to adapt the training. A mobile application for home use is only reasonable if it is intensively introduced during inpatient stay. A mobile application only for home use seems to be critical due to the decreasing self-motivation of the patients at home and no supervision of the training. Training adaptation should be performed by therapists and not by patients themselves. Stimuli and motivation to perform training is higher in a clinic setting and the resulting therapy success might be higher too.

Data usage for training and for training feedback is also legal and important to improve both training and therapy. To use data for commercial purposes or monitoring of the training is not legal. The topic will change over time and at the moment, the balance between data usage and data safety is not available.

Using mobile apps with exergames and new technologies the amount and quality of the data has to be considered during the development process. What data (age, sex, diagnosis, etc.) will be collected? Who is going to collect the data?
An advantage of the app might be:

- Ability to improve system quality.
- Easy analysis and display of the data.
- Integration of a diary for the patient to report on their well-being or pain to adapt the training would be good.
- Ability to recognise whether a patient trains or not at all.

With the data collection, an intelligent system might be built. However, data from one app might not be sufficient for further development and improvement of the training device.

Exergame concepts
Impressions based on the ExerCube videos were very positive and interviewees showed great interest also in the already collected feedback from the patients. Overall, interactive exergames seem very interesting for therapy and training. However, they were uncertain about the aim and purpose of the training in the ExerCube and what could be replaced by the ExerCube.

Advantages of the Exercube might include the following:

- The time-saving fitting of the individual to the device could potentially allow therapists during one training of a patient to already prepare the next patient.
- Games can be played in a sitting position, e.g., wheelchair.
- The everyday-oriented/real-world oriented games, e.g., grocery shopping, that allows patients to train in an activity in a safe environment. This could attract non-gamers. However, maybe the inclusion of a virtual reality headset could be more appropriate.
- Being able to include different landscapes besides the real-world scenarios to increase training variability and include wide-ranging movements (e.g., for a grocery shopping task). However, the (haptic) feedback is missing.
- It could create a competition or challenging scenarios among users.
- It can provide an attractive design, however, the games should be serious games and emphasise the therapeutic/medical aspect.

- The early involvement of therapists during the development process to determine important therapy aspects and the benefit of the training with the ExerCube and what alternative therapy options might exist is important. Here, advantages and disadvantages of the ExerCube training could be evaluated and could be adapted depending on the recovery process of the patients.

Games should include a clearly formulated task, e.g., to have a shopping list for the grocery shopping task, and after task completion feedback should be provided.

The interviewees could imagine:

- To use the training device all over Switzerland in several rehabilitation centres.
- To install more than one ExerCubes in a rehabilitation centre and therefore, increase efficiency.
- To use the ExerCube in an outpatient setting in a clinic.
- Financial aspects and how to reimburse the training through insurance companies would have to be discussed if the pilot project is successful.

Regarding a pilot study/implementation in clinical routine, interviewees emphasised:

- They would need to know more details regarding the planned sample size, eligibility criteria, and further aspects, e.g., whether other insurances would potentially cooperate as well, to implement a pilot study across Switzerland.
- They would pay attention to the marketing aspect - the successful project should be presented well to inform many patients.
- Financial aspects have to be resolved. Would reimbursement be covered by an individual's supplemental insurance or by their basic health insurance?
- Could the system motivate individuals to train, e.g., to decrease hospital stay?
- The training concept should be easy and efficient in general and should cover therapy areas that are not or not yet covered by other therapeutic disciplines.
- If therapists have to be retrained to work with the ExerCube, there could be some problems if therapists are not open to new technologies.
- Use cases should be established to find out how and for whom the ExerCube is an appropriate training system.
- How does the ExerCube fit into an established concept in a clinic? How can the ExerCube be implemented?
- Users should be convinced to use the system and therefore, integrate the device in their own daily/weekly routine. Here, the first level support is extremely important including device introduction and explanations how to use it.
- To include health insurances during the development process is essential to learn about the insurances' requirements of the system.

HCI Games Group, University of Waterloo

Version 1

So far, no interviews were conducted at HCIGG. The reasons are: 1) a long process to obtain permission from the university's ethics committee, 2) the restricted access to interviewees in autumn 2021 due to the COVID-19 pandemic, and 3) no access to interviewees during the lockdown during January and February 2022 due to the COVID-19 pandemic. As soon as possible the planned interviews will be conducted as the restrictions to approach potential candidates will be lightened or omitted.

The results from these interviews will be added to this document.

Version 2

The Canadian team at the University of Waterloo identified a number of key themes that describe the participants' expectations and suggestions for exergames through our thematic analysis of the interview/focus group data. Throughout the interviews, participants kept reminding the team that a one-size-fits-all configuration does not exist, especially when it comes to older people that have not only numerous, but various health concerns that the exercise must accommodate to provide a safe and enjoyable experience.

All participants agreed that movement is important in their daily lives and had a clear idea of what they expect to gain from exercising. Their expectations boiled down to either improvement in health/physical abilities or rehabilitation. In addition to general health improvements, participants also mentioned specific aspects of both their physical and mental health that they wished to improve: For example, ability to move, balance, strength, reflexes, cognitive abilities, memory. As older adults, all of our participants reported struggling with various physical/mental issues, including pain in many body areas (most commonly joints and legs, as well as muscles on shoulders, hips, and back), medical issues such as diabetes, blood clots, vision deterioration, and cognitive issues such as fading memories.

All participants reported to have never played an exergame before, but did have experience playing digital games. All expressed interest in trying an exergame pending availability (discussed in section 2.6). When prompted to imagine what a game used for exercise might look like, most participants mentioned sports games (simulations) on Wii, while two participants also thought about Dance Dance Revolution and expressed concern that such games were too "intimidating" (P5) for them due to their high motion intensity.

While all participants reported having prior experiences with video games or playing games digitally, they also pointed out that other people in this particular age range may have never played one before. Therefore, it remains unclear how receptive users with no prior game experiences will be toward exergames.

Theme 1. Elderly people want to be treated more than just old people
Participants frequently discussed wanting to have a stronger body and a younger mind. Through exercising, they wish to improve their abilities to perform daily tasks such as moving, housekeeping, and grocery shopping, mitigate risks for physical/mental deterioration in the future, and feel younger and more confident.

“Nobody wants to get old, so we don’t necessarily want images of being old shoved in our faces.” (P13)

Participants also commented that exercising solely for the purpose of doing exercises would quickly become boring . Instead, they preferred less obvious exercise and wanted to have fun in the process. To that end, participants suggested incorporating elements of competition and/or challenge in the exergames to keep it more fun.

Furthermore, participants described some activities showcased in the prototype, such as picking up groceries and gardening, as condescending, especially when the participant had no problem performing such actions independently. The presentation of such activities diminished them because of their age. *“It just felt like, ‘you are old, and so you are in the garden, you are doing this.’” (P1)*

“I’m not sure if people would feel in some way lessened, by being told that they need practice on how to pick up the (groceries). I’m wondering about the ego effect on people… I can see that it’s good to be able to have the limberness to do it, but I can also see where people might just feel a bit insulted.” (P3)

While participants were aware that their abilities may possibly deteriorate in the future, they did not want to be treated as helpless unless that possibility became reality. Some participants agreed that some sort of physical support would be necessary to accommodate users who require mobility aids (e.g., a cane, a walker), but all of them were apprehensive of having a harness built into the setup. One participant described that the harness made them *“visualise a child in a jolly jumper” (P8)*.

“I think that, mentally, when you lose it, there is no way that you get it back.” (P3)

Theme 2. But they are not in their 20s either…
Participants were most concerned about safety. As much as they wanted to feel younger, they were still aware that their physical abilities were not the same as in their younger years. They did not want to risk further damaging themselves while playing exergames.

“I would be afraid of injuring my knee, if I stepped on it the wrong way or twisted it the wrong way, and made it worse.” (P7)

Participants agreed that growing older brings more health concerns that vary widely between different age groups. The question in terms of safety then becomes whether they are doing the

right kind of exercise, and whether it is customised to their specific needs and limitations. For example, some participants felt the gameplay speed on the demo video was too fast for them, while others thought it was too slow. Furthermore, some participants were concerned about motion sickness if they had to rapidly turn their body to react to events happening on both sides of the panel.

“For instance, if for whatever reason, my playlist included an exercise that was painful, I would really like to delete it, and it should record the fact that I skipped it and that way, the therapist or the trainer could look at it. And so, “oh, you jumped over this,” and you say, “yeah, it hurts. All of a sudden it's hurting my arm. So can we do something else?” And that way the, you know, the video sequence can be adjusted.” (P5)

Theme 3. What constitutes a good exergame user experience

The fundamental difference between the target audience and younger generations is the variance in abilities between individuals. In addition to the fact that elderly people are more likely to be experiencing one form of issue or another that makes exercising more complex than just going outside and doing it, participants were also concerned about the learning curve of exergames. They mentioned needing extra time to learn new things, and without the ability to take things at their own pace they were less likely to even begin the learning process.

“...I don't want a lot of people there because I have to go on a slower pace and I don't want to, I don't like the feeling of holding people up.” (P3)

While the participants interviewed all expressed interest in trying the exergame, whether they will come back to it depends on how well their experience goes.

Immersion & Realism

In terms of the visuals, participants preferred the natural scenes shown in the demo. As many elders have health issues that limit them to their homes, it is hard for them to frequently travel to locations where they can experience nature. Alternatively, the 3-panel surrounding setup creates an immersive environment for users to *“(feel like) you are actually doing this in reality.” (P4)*

“...especially like walking along a trail, walking down a dock and lifting and bending, like you're picking stuff off shelves and that I thought that was more like daily life. And I would think it would be more relevant and people might find it more interesting.” (P7)

Participants also wanted to have more real-life scenarios, e.g., events they were more likely to have in everyday life. The participants frequently mentioned that they as seniors were more familiar with realistic styles and actions they would perform in real life, rather than the fantasy and “cartoonish” concepts video games usually feature.

“Since you don’t walk into branches a lot of the time right? In the real world nobody really walks into a lot of branches as they leave on their walk, unless you live in the jungle or something.” (P4)

A few participants also mentioned wanting to bring their own playlist to exergaming sessions as they usually do during exercises.

Autonomy

All participants wanted the exergame to be adjustable in terms of content, style, difficulty (speed), volume, etc., so that they could select the most adequate settings suitable for their needs and limitations. Participants also mentioned wanting the ability to pause and resume the game as needed.

“I think it'd be more realistic for me if I was walking in a park, but then again, I had the ability to make a wider range of motion to make it a little bit more intense. So if you can increase the intensity level or someone has the ability to create something that's slower for them if they need it or a little bit more intensive if they need it. I'm assuming in this game, there must be levels of intensity you could pick.” (P8)

There should also be a variety of scenes associated with the same exercises for the users to choose from.

“Let's go for a walk through a woodland, let's go for a waterfall, through a Zen flower garden or let's just walk through my local grocery store.” (P13)

Reward & Replayability

Participants frequently mentioned wanting challenges and improvements as measurements of their progress in exercising. Clear metrics to gauge the users’ performance would provide them with motivation and increase their enjoyment of exergames.

“I would know that I started off at 4 and after a month I'm at 9 and I can continue to use it because the scale goes up to, you know, I don't know, 40 or 100 or something, and a self-competitive, self-improvement scale built into it would be so important. I would hate it if I didn't know. And I would go, ‘well, I think I'm doing better with this.’” (P10)

While all participants mentioned that they wanted to play exergames at their own pace, some were open to the idea of occasionally bringing in their family members for collaborative play. They could be game partners with similar exercising needs or younger family members that just wanted to have fun.

“Makes it more fun. I think you'll end up laughing and you know, it'll be fun and silly, and I think when you do it with other people, you don't really realise how so much time passes by, or that you're actually doing, quote, ‘exercise’” (P1)

One participant mentioned an app called Seven which features a progress tracking system that accumulates reward points in terms of hearts with continuous attendance of daily sessions, and reduces otherwise. Once the hearts are exhausted, the progress is reset and users must restart the training schedule. Such systems with rewards and penalties can serve as an incentive for users to establish a routine of exercising with exergames.

Theme 4. Tutorials: ExerCube vs. Personal Trainer

To be able to play at their own pace (e.g., solo), participants needed simple and clear instructions to operate the system as well as clear feedback from the system to ensure that they perform their exercises correctly.

As participants expressed their preference for solo play, it is imperative that the system could provide users with feedback and guidance in a concise manner. Participants recommended having more than one form of feedback which they can freely choose to enable, such as visual indications (scores, grades, screen shakes when incorrect, etc.) and audio feedback (speech and sound effects).

“I would respond very well to a positive, feminine voice, only because I've seen some of the exercise video presentations where this guy is growling at the participant, urging them on. (The feminine voice) just sounds much more friendlier.” (P5)

As elders, participants were more used to asking questions to a real person, rather than trying to figure things out with the machine. Some participants suggested incorporating physiotherapists/personal trainers into the exergaming process, both by having them design the program to ensure it is safe and actually helpful for users’ specific needs and concerns, and by having them monitor users’ progress throughout. Participants believed that having a real, professional person examine the exercise program would give them confidence in its results.

“I think that you can look at somebody’s specific condition and say, this is exactly what you need to fix and heal this condition. And then to be able to say, this is the specific movement that will fix that.”(P13)

Theme 5. Fun exergames and where to find them

Finally, participants were also concerned about the availability and location of exergames.

As much as participants were interested in playing exergames at home, they were concerned about owning an exercube. First of all, they were unsure whether they could afford the costly setup; second, the exercube requires dedicated space that may not be available in their homes; third, setting up the exercube would prove troublesome for some elders.

Most participants did not go to gyms. Generally, they felt that purchasing a gym membership would be a waste of money since they didn't exercise enough for it to be worth it. Some participants also mentioned that exercising around younger people that were faster and stronger would discourage them.

“Nobody wants to be the object of everybody's attention, you know, especially if they're struggling. Nobody needs a bunch of kids all standing around laughing at them…which I've seen in many gyms, and nobody is doing anything about it” (P7)

As seniors, participants would go to nearby community centres for their social needs. They believe that they are great locations to set up exergames because community centres are usually free of access and have staff to ensure safety. Also, since most people in community centres are seniors, they are more likely to talk to each other and help each other learn to play exergames.

“The personal element, at least initially, because once there is a cluster of seniors who are familiar with it, they'll pull other ones here. Also, seniors tend to talk to each other. If I see a senior struggling with something, I'm very likely to approach them and talk to them.” (P5)

Of course, their willingness to play exergames also depended on the distance they would have to travel to access the exergames, especially when there are no community centres within walking distance. Some participants who lived in senior buildings also suggested the fitness rooms in their buildings as a possible location to set up exergames.

“If I have to drive somewhere to go to walk in a cube to look at nature, I may as well drive somewhere where I can walk in nature.” (P13)

Bonus: what one participant imagined playing exergames to be like:

“So I would see this exergame to be the thing that is done as a result of the physio, after the physiotherapists or the trainer. And it could target, say, somebody like myself, who had damaged their shoulder in a fall and the physiologist or trainer would select the video saying, ‘okay, you're supposed to watch this and this and this’. And that would go on my playlist. So when I approach the machine, it would pop up and say, ‘okay, for the next two weeks, we're going to do this’ and run me through it. Very often they just give you sheets of paper. I put them in a binder and then I go through the binder on my own, but it would be very nice to have this device, either in my home or at the community centre where we could deliberately approach it. And it would walk me through what I'm supposed to do in those, like I said, those exercises. So this would be selected and targeted for my specific needs and basically a playlist, I guess.” (P5)