Final report

November 2017

Innovating for Improvement

Development and pilot testing of an App designed to deliver Functional Strength Training to people after stroke: FesSTivAPP

Norfolk and Norwich University Hospitals NHS Foundation Trust

The Health Foundation

About the project

Project title:

Development and pilot testing of an App designed to deliver Functional Strength Training to people after stroke: FeSTivAPPS

Lead organisation:

Norfolk and Norwich University Hospitals NHS Foundation Trust

Partner organisation(s):

University of East Anglia

Norwich Community Health and Care NHS Foundation Trust

Project lead(s):

Dr Kathryn Mares

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Part 1: Abstract

The innovation

We designed a bespoke app to enable physiotherapists working with stroke survivors to prescribe an arm exercise programme to their patients. Physiotherapists can select a patient appropriate package of arm exercises which are tailored to the level of movement recovery experienced by the patient at that time. The app incorporated high quality videos of stroke survivors themselves performing the exercises.

The project

Over 1,200 people have been admitted to our implementation setting with a diagnosis of stroke. Loss of arm movement is a significant problem for people after stroke and an important factor driving movement recovery is engaging with the exercise programmes that are prescribed to them. We recruited 37 people with an arm weakness to take part in a pilot study testing the feasibility of using the app versus usual care (exercise prescription delivered by paper). We measured impact through activity performance measures and both patient and therapist focus groups.

The impact

We experienced intermittent functionality problems with the app but received good feedback from both patient and therapists about how to move forward with our innovation. The main challenges came through managing the functionality problems experienced with the app. We worked with a company that shared our future vision for the app and so were able to address these issues in a timely fashion. We would recommend that co-production, collaboration and a shared vision is essential to the development of innovation within a healthcare setting.

The future

We will be seeking further funding support to develop the app into a product that has greater potential for spread before seeking to embed it within the healthcare delivery teams.

Part 2: Progress and outcomes

Introduction

Stroke is a major health problem in the UK. Locally over 1200 people have been admitted to the stroke unit at the Norfolk and Norwich University Hospitals NHS Foundation Trust in the past year. The most common problem following stroke is weakness or complete loss of movement affecting one side of the body.

The most important factor driving movement recovery after stroke is lots of physical practice of the movements that each individual finds challenging. It is therefore important that stroke survivors engage in self-directed exercise programmes that have been prescribed by their physiotherapists.

Physiotherapists identified however that patients are often not motivated to complete their exercise programmes particularly those targeting movement loss in the arm. This is supported by research which has shown that stroke survivors might receive as little as 4 minutes a day of exercises targeting movement recovery of the arm.

Current practice within the therapy team when they did provide exercises was to use a resource known as '©Physiotools'. Whilst ©Physiotools does have a repository of exercises specific to 'neurology' the therapists felt that they were not always appropriate e.g. they often had to overwrite the default script to try and describe the exercise. These exercises were handed out on paper sheets which were reported to be 'lost' within the rest of the paperwork that was sent home with the patient.

The start of this project coincided with a time when the physiotherapy team were looking to facilitate communication between different healthcare Trusts and default exercise programmes that had been developed collaboratively. Thus they were open to the concept of a change in provision.

The project

The following diagram shows how we went about identifying the innovation which we hoped would increase participation in a prescribed exercise programme.

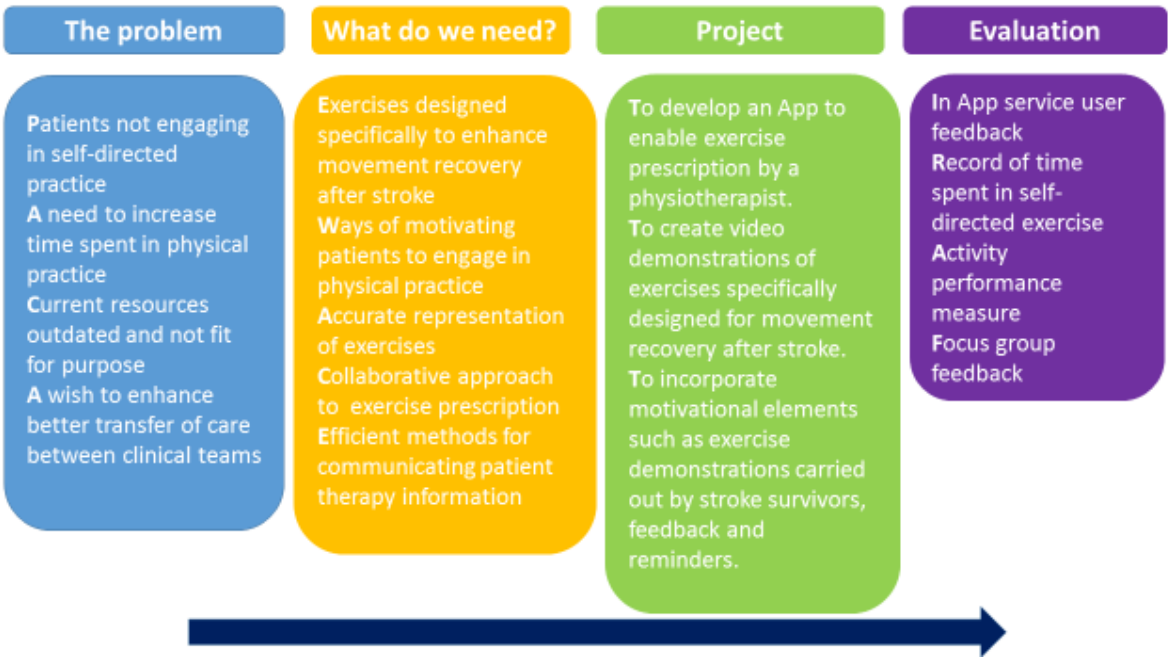
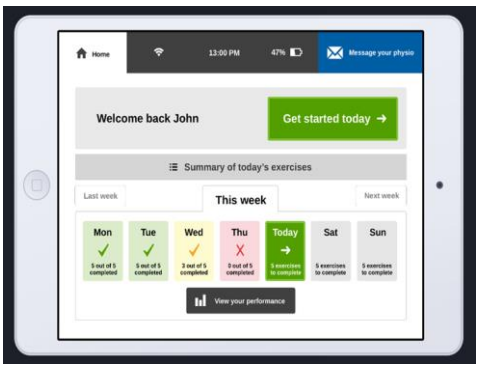


Figure 1: Logic model showing project development process

We spent some time investigating current exercise apps and realised that there was nothing appropriate to movement recovery after stroke. We therefore worked with a software company to create our bespoke solution to deliver a physiotherapy programme via an app.

Functionality includes selecting a patient appropriate package of arm exercises which are tailored to the level of movement recovery experienced by the patient at that time. Physiotherapists can adjust these and the regime as they go through a four week programme. There are over 60 different exercises on the app supported by videos of a high quality filmed with real patients in response to patient feedback.



We had good input from the UEA stroke user group with respect to the design and functionality aspects in the development phase of the app. We made some initial

adjustments to the app content as it became clear at an early point in the project we would not be able to add reminders as a function of the app.

We carried out a small scale RCT, with patients meeting the inclusion criteria and under the care of the Stroke team, being randomised to receive either usual care (prescribed exercises on paper) or their exercise prescription being delivered via the app. The following flow chart shows the process that we followed.

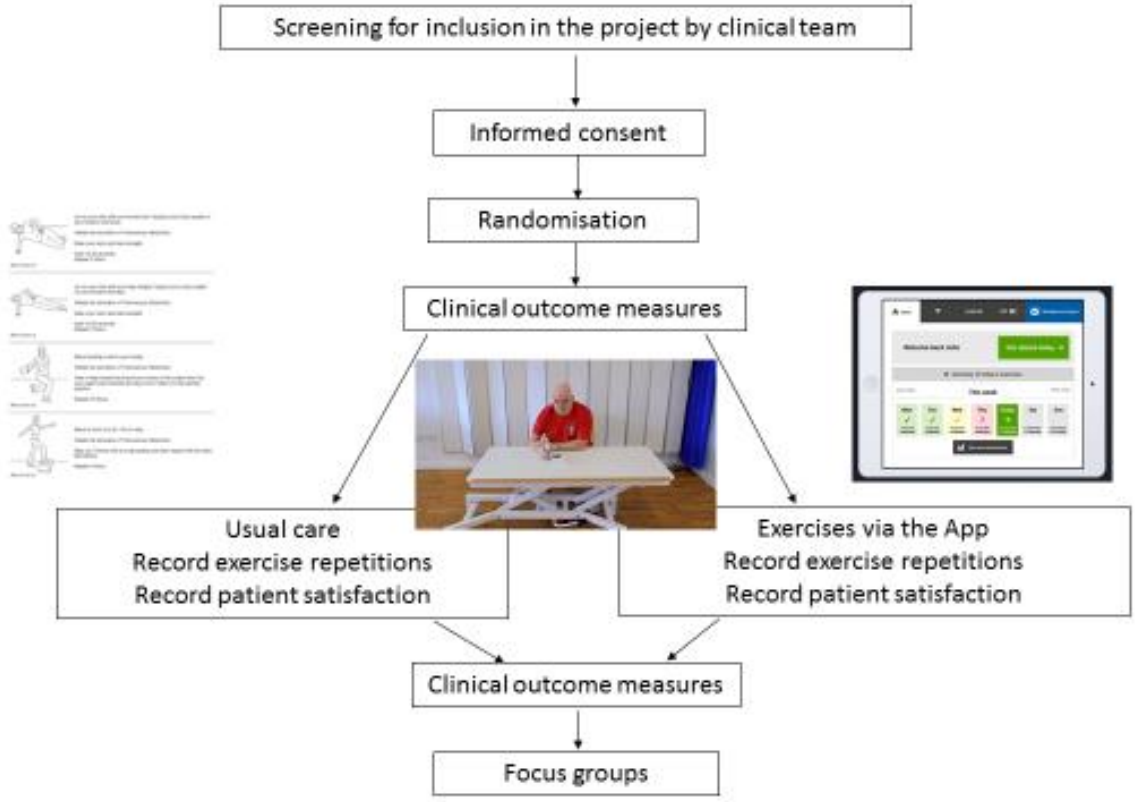


Figure 2: Process for project – Evaluation cycle

Therapist feedback was gathered via a second focus group. We aimed to recruit 40 people to this project from three health care settings across the stroke pathway. Acute hospital ward, Beech rehabilitation ward (community based site) and community (early supported discharge (ESD) team in people's own homes). We followed a plan-do-study-act (PDSA) methodology.

The project process ran according to plan except for the recruitment sites. There were significant delays in being able to get approval for the project to be carried out by the Research and Development department in the acute hospital. This meant that at the time of this report we have not been able to include data from participants from that site and we are reporting on the findings from 37 of the 40 people we had intended. We also had to alter our plans for some of the functions on the app. Significantly we were unable to provide a function that allowed us to create reminders for the participants.

Monitoring Impact

The following chart shows the participant flow through the project.

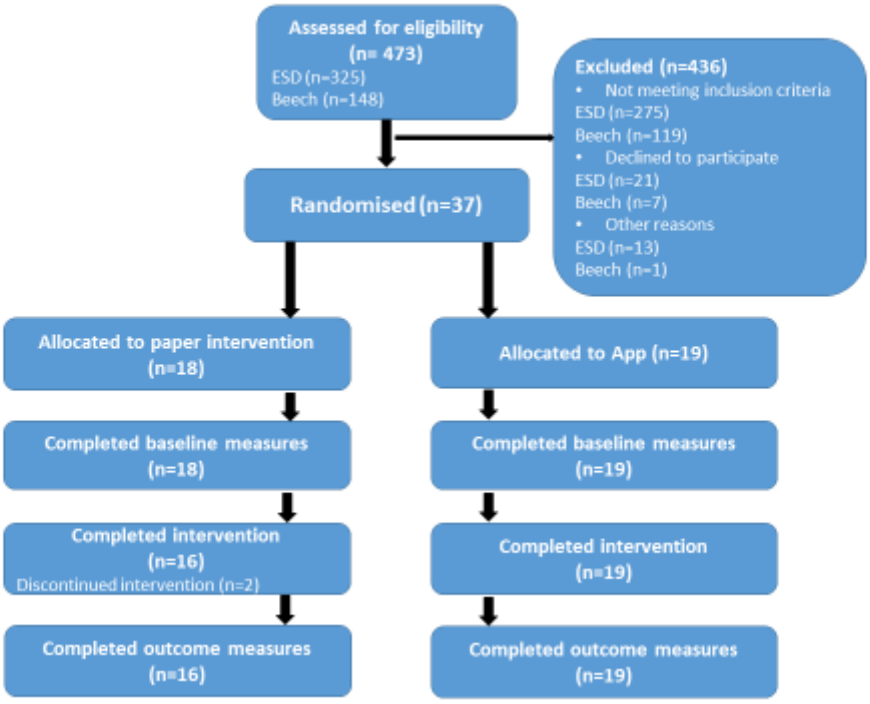


Figure 3: Participant flow through project

In order to be included in the project patients had to meet the following inclusion criteria (also see protocol in appendix):

1) Adults aged 18+ years, diagnosed with stroke (infarct or haemorrhage)
2) Presenting with an upper limb impairment and who would usually be prescribed an active exercise plan by therapists on the stroke pathway teams.
3) Can follow a 1-stage command i.e. sufficient communication/orientation for interventions in this trial
4) Able to access the material on the app – i.e. sufficient vision to be able to see the video demonstrations.

Data was gathered through a variety of ways:

Baseline and outcome data from clinical outcomes was collected through assessments carried out by an assessor blinded to group allocation. These were the Motricity Index (MI) and the Action Research Arm Test (ARAT). Exercise frequency and satisfaction with the exercise programmes were collected via paper diaries and an in-app function.

Qualitative data was captured via a field diary and focus groups (therapist and stroke survivors) held towards the end of the study.

Adverse events:

We had four serious adverse events during the study all were admitted to hospital for other medical reasons – two were subsequently able to continue the project and two were withdrawn. During the study there were three adverse events one of which lead to one person having to have a modified exercise programme and who then completed the project. A second person had to stop due to generalised central stroke pain, medication was reviewed and they also continued with the project. The third participant had a muscular strain unrelated to the exercises and who also continued the project.

Quantitative findings:

Unfortunately during the project we discovered that the implementation of the Motricity Index (MI) had been done incorrectly. We believe this was down to inexperience in the use of these measures by the individual carrying out the outcome measures. Our previous trials have always employed an outcome assessor who had a physiotherapy background and who was inherently familiar with the terminology and methods of outcome assessment used. We had carried out a training programme and assumed sufficient training had taken place but this clearly was not adequate. In future trials we will audit the performance of outcome measurements and provide supplementary training materials such as videos to prevent this situation happening again.

This means however that we are unable to rely on the MI data and will not be reporting on the results of this. We were also unable to rely on the data regarding how many and how often participants completed the app exercises – this was due to intermittent functionality problems with the app preventing complete recording for all participants. This data has been collected however for the paper group. We were hoping to compare the adherence between the two groups but have been unable to do that.

The following table shows the mean change and standard deviation scores for the ARAT as a whole group and also per intervention group. The ARAT is scored out of 57 and higher scores indicate greater recovery of arm function. At the time of this report we had not received

ARAT score	All participants	Participants receiving APP	Participants receiving paper
Baseline mean (SD)	30.3(18.9)	29.7(20.6)	27.7(39.8)
Outcome mean (SD)	42.5(17.1)	42.6(17.1)	39.8(18.3)
Change in mean score	12.2	12.9	12.1

Table 1: Table showing mean and standard deviation (SD) scores for ARAT.

Both groups irrespective of intervention have shown an improvement in their ARAT score indicating an improvement in their arm function. With such a small number of

participants this study was not powered to detect an effect of the app intervention although there does seem to be in indication of no difference. It did seem that the ARAT was a useful outcome measure for evaluating change in function in this group of people.

The following graphs show the individual participant change score for the ARAT. As indicated by the standard deviation there was considerable variance between the participants in each of the groups. As this project was carried out with

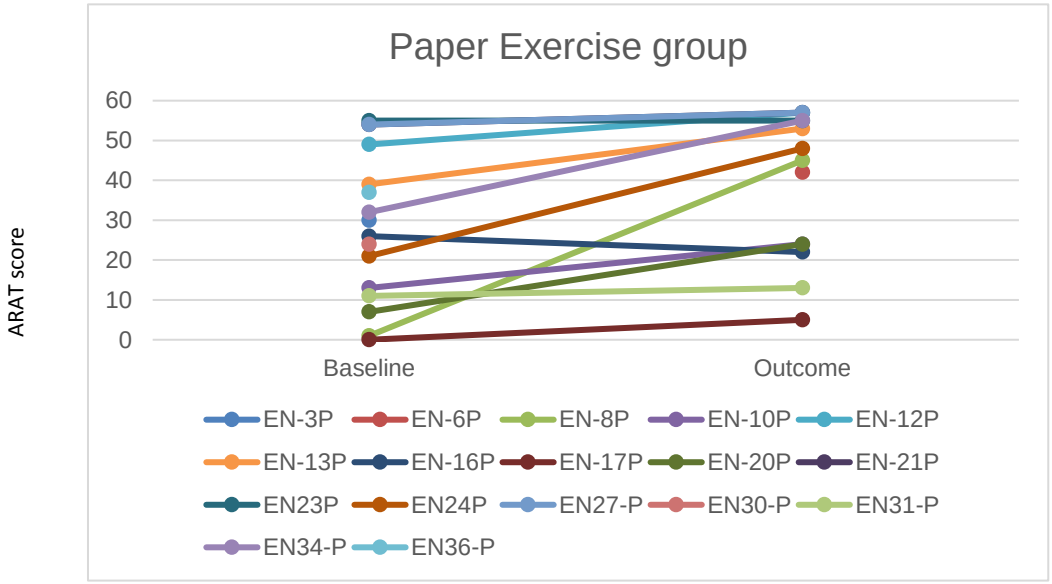


Figure 4: Line graph showing change in score between baseline and outcome of ARAT for paper exercise group.

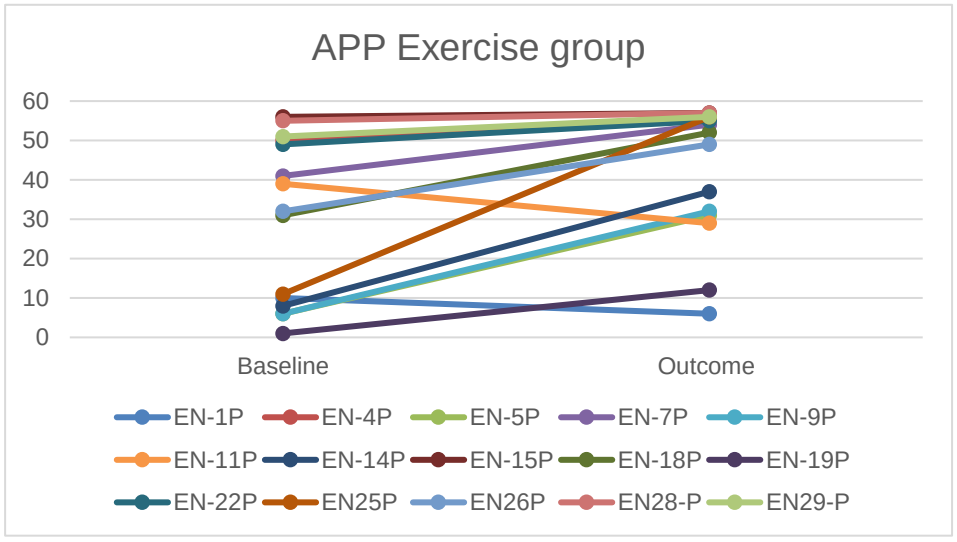


Figure 4: Line graph showing change in score between baseline and outcome of ARAT for APP exercise group.

Analysis of the diaries recorded by the participants receiving paper showed good compliance with this form of exercise delivery. This was an interesting observation as members of the therapy team did note that before taking part in the project

some patients were non-compliant with their exercise regime but as soon as they started the project they began to engage. This type of response has been widely reported in research trials and has been described as the 'Hawthorne effect' which is where individuals modify an aspect of their behaviour because they are aware that it is being observed. This effect may be the result of taking part in a project where individuals may feel some responsibility to engage with the intervention or it may be because they knew that the exercise diaries would be looked at by the therapists. Until the project there had been no way of capturing engagement with the exercise programmes so this may be a useful addition to exercise prescription within the clinical teams.

We reviewed participants who decreased their score at outcome (EN11 and 16), EN11 and EN16 were unable to fully complete their outcome ARAT because of back pain or just declined. EN1 also decreased but we were unsure why.

Qualitative findings:

The project manager completed a field diary throughout the course of this project. This highlighted frustrations with the technology when it was not working correctly and identified at an early stage things that needed to be changed with the app. These things were corroborated by the focus group feedback from some of the participants that had used the app to receive their exercise prescription. We have provided some direct quotes from these groups below and used the EAST model to theme these.

Patient focus group:

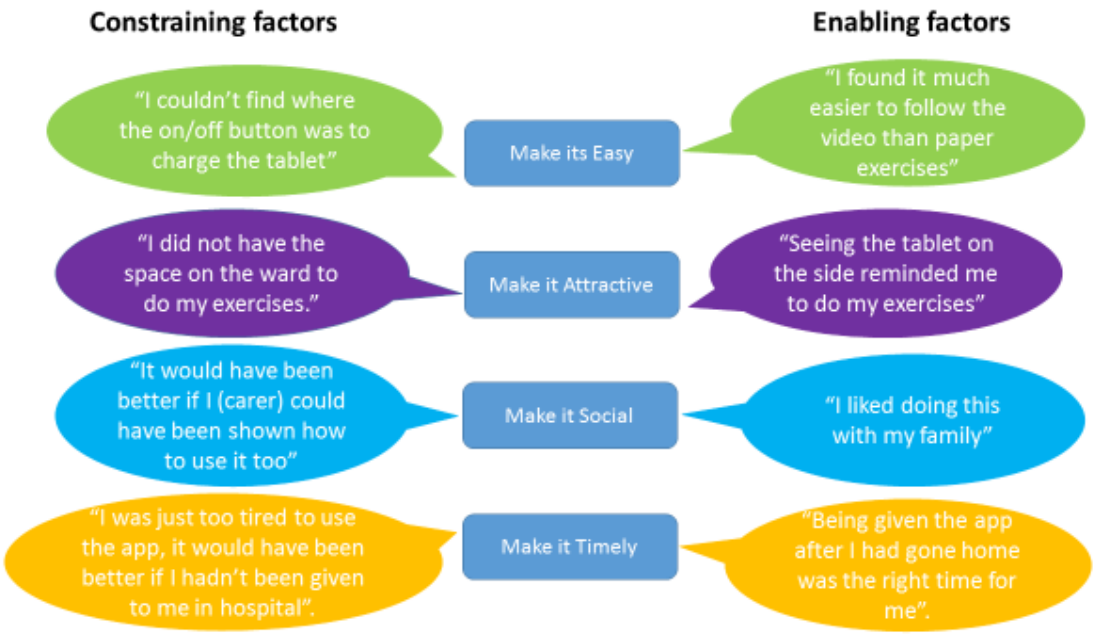


Figure 5: EAST model showing comments from participant who had used the App

In the diagram above the themes identified as constraining and enabling are defined according to feedback from the patients after they had completed their

participation in the project. This information will be used to guide subsequent development of the app. Please refer to part four ‘learning from your project’.

Therapist Focus group:

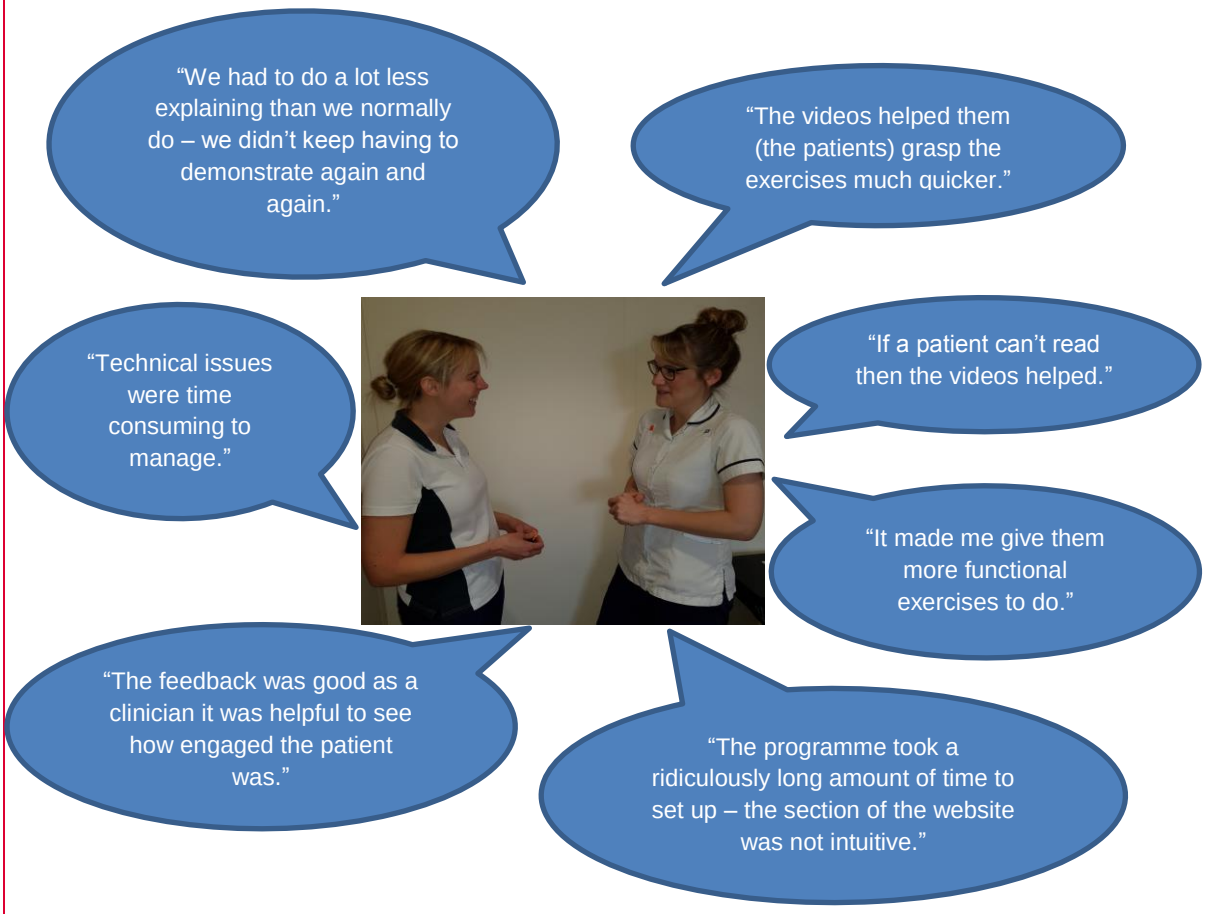


Figure 6: Illustrative comments from therapist focus group

Part 3: Cost impact

This project took place with the clinical teams providing healthcare to stroke survivors across Norfolk. The service is provided for people diagnosed with stroke from the point at which they are admitted to the acute hospital and into the community setting where they may receive inpatient rehabilitation and/or early supported discharge from hospital. The whole service irrespective of setting is commissioned by the acute Trust.

We did not carry out a financial evaluation of our project as this was a very early stage evaluation of a product that is not ready to be commercialised. With an underspend we did however commission the creation of an economic model that will be used in future evaluations of the product. At the time of this report the model was still being completed and we will provide this to the Health Foundation once it has been completed. We are currently working to provide robust cost data based on our previous studies and related research.

We anticipate that direct care costs will remain unchanged during the initial phase of physiotherapy treatment. The average length of stay of patients in the in-patient ward is 32.6 days and in the ESD section of the stroke service is 32.8 days. The in-patient price per day is £413.41 and ESD cost per contact is £111.00. Consequently, the cost per patient is:

- £13,477.17 for in-patient stroke rehabilitation
- £3,640.80 for ESD stroke rehabilitation

However if the app is successful in motivating patients to engage in more self-directed exercise then the potential for improvements to arm recovery is high and can be sustained. Poor recovery of the arm leads to greater dependence on carers for activities of daily living, social isolation and reported poor quality of life. If the app proves able to engage patients in more exercise then the consequent improved recovery will reduce long term tangible costs to the health service from physiotherapy/occupational therapy and related follow up services such as home or residential care.

Increased functional strength reduces the more intangible downstream costs from any adverse economic impact on patient's ability to participate in the labour market and related welfare payments.

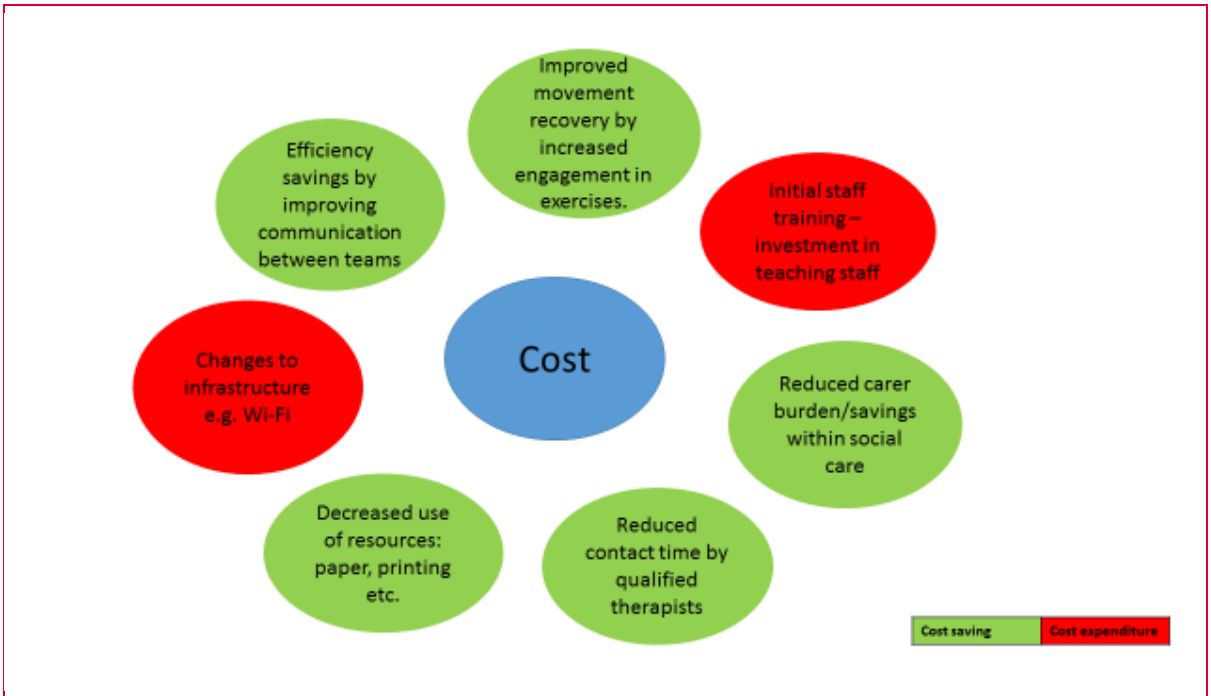


Figure 7: Diagram to illustrate potential cost savings/expenditure from use of innovation

Part 4: Learning from your project

Enablers	Lessons learnt	Looking forward
Leadership	• The project manager was a well-respected member of the clinical team. Confidence in this person meant that the clinical team were more likely to take part in the intervention and be supportive of things that didn't always go according to plan.	• Identifying key people in any organisation to lead change is likely to increase the success of a project.
Shared vision and ownership	• The software company were invested in helping us make this project work and we established a good relationship with them which enabled us to communicate easily. This meant that they resolved issues throughout the project as the product was being used and tested. • IT support at the community trust was crucial to the overall working of this product. • Therapists were the people who initiated the project	• Future projects need to engage key stakeholders as early as possible in all aspects of a service change. • Collaborators must have a shared vision for the project.
Infrastructure	• The perception that people would not be able to use the device because of access to Wi-Fi was largely incorrect. 2/473 people had to be excluded during the screening process because they did not have Wi-Fi.	• Testing is essential as perceived barriers may not be present.
Unconscious bias	• We found that age was not a barrier but prior use and confidence with technology did have an influence on recruitment and subsequent support during the project.	• We need to refine the innovation so that service delivery options can be tailored to the individual.
Institutional support	• We found that support from managers and colleagues was hugely important to the progress of the project. Despite the delays we did experience, the support of senior managers did in the long term enable us to move forward with the project at the acute Trust.	• Engagement with key stakeholders within the leadership structure of an organisation is important in managing cultural barriers.
The 'marmite' effect	• We found that individuals either loved or hated the innovation. • The use of videos to demonstrate exercises was universally supported.	• Future development of the product needs to take into account the mode of delivery and offer a choice (e.g. paper or app) but still provide a resource for video viewing.

Communication and team working	• Communication between all members of the project team ensured collaborative problem solving and effective action research. • Respect for individual skills ensured effective balancing of roles. • External mentorship throughout the project was effective and should be incorporated into future projects.	• Maintaining communication and working collaboratively to a joint vision is important. Project mentorship should be incorporated into the project plan.
Behaviour change	• Whilst we expected the potential for improved adherence in the app group we were surprised to find that the paper group also increased adherence. They were positive about the diary and how that motivated them and allowed them to look back on their progress over the four weeks. • App users said that they found the presence of the tablet motivating. • The app users found the videos very helpful and reported that they were able to watch the action on the screen and correct their own movements to match the ones they were seeing. • Therapists felt that participants were more motivated to do their exercises. • In the paper exercise group the participants were given a quantity of exercises to complete – this was something that they found motivating.	• We need to add more videos to the digital resource and provide capacity for therapists to prescribe quantity of exercises. • We need to consider what the control group would be in the future as the current method does not reflect usual care and led to increased adherence.
Barriers	**Lessons learnt**	**Looking forward**
Processes and procedures	• Mistakes made completing the outcome assessments.	• In future studies to check accuracy and reliability of outcome assessment • To provide videos as a reference point for assessor to check back
Functionality	• Despite the fact that we thought we had a working product software glitches appeared throughout the project especially with the function for recording feedback.	• We will need to seek further investment to support changes to the innovation.
Infrastructure	• Initial problems with gaining reliable Wi-Fi access on the ward for patients – this was resolved by	• This information can be used to inform early discussions with relevant IT teams in the future.

	installing boosters in the ward environment.	
Research governance	• We experienced long delays to the research governance approval for the acute trust. This has been resolved and we have extended the recruitment phase to continue testing in the acute environment.	• Engaging research and development teams as early as possible for future studies may help accelerate governance processes.
Clinical team engagement	• We spent time discussing the project with the therapy teams but not with other professional teams.	• In future we would need to expand discussions to include other professional groups. This would ensure a shared vision and ownership of the technology solution and innovation. • We would also need regular reviews with the wider team to maintain engagement throughout the course of the project and keep a workplace buzz.
Physical environment	• Throughout the project we discovered that individuals were not able to complete exercise programmes because of the environmental barriers on the ward (small table, no dedicated space, lack of access to equipment).	• Potential environmental barriers need to be addressed and will rely on a shared vision and values with the clinical team
Situational barriers for participants	• A number of people declined taking part in the project as they felt it was not the right time for them. This was either due to medical, emotional or fatigue. • We were also aware that some people did not complete their feedback because of transitions in care or because of coming to terms with the wider consequences of their stroke.	• We need to be mindful of the wider impact of ill health during rehabilitation. • Further resources to support use of the technology would have helped some people – this could include a start-up guide of a brief manual.

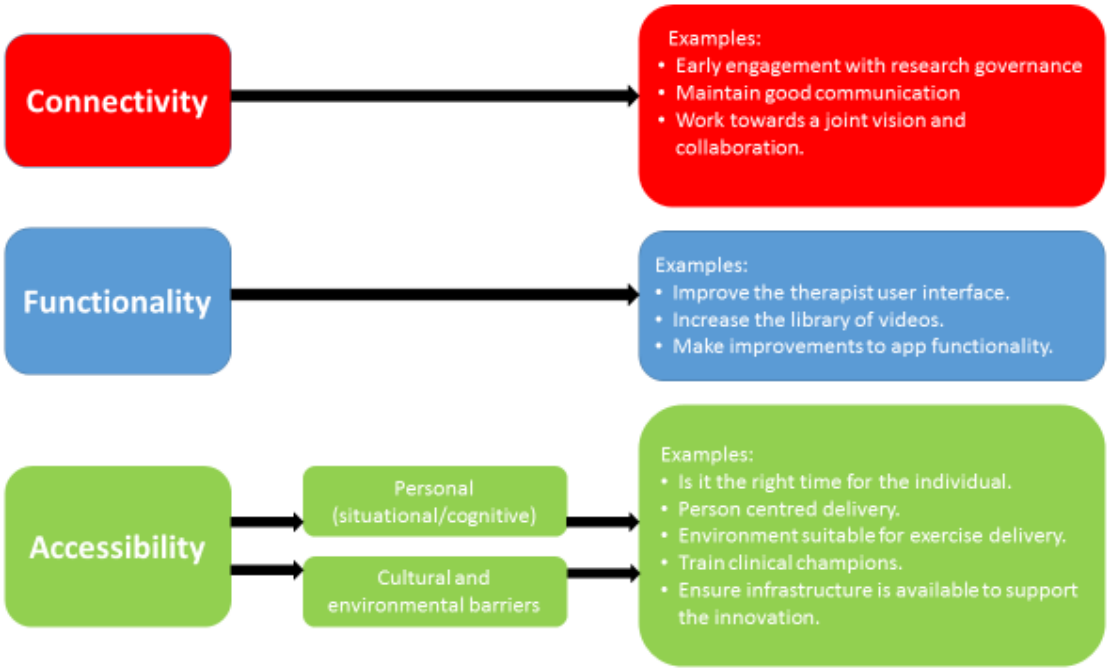


Figure 8: Diagram to key themes for moving forward

Part 5: Sustainability and spread

Sustaining the innovation

In order to sustain the innovation we are going to have to find further investment to improve the functionality of the App. We have identified that the best way forward for our innovation will be to design a webapp. This will increase the ability to 'scale-up' the product to something that will be commercially viable as well as more 'user-friendly' for both patients and therapists.

Potential sources of funding include:

- Innovate UK
- Medtech accelerator
- NIHR HTC
- NIHR personal fellowship grant applications for Dr Kathryn Mares.

Interest and Recognition:

The team were nominated as one of the finalists for the 2016 Health Enterprise East Innovation Awards.

We have presented the ongoing work with the app at a number of conferences nationally and internationally.

Stroke Study Day: Norfolk and Norwich University Hospitals NHS Foundation Trust. Platform presentation.

School of Health Sciences Research Study Day: University of East Anglia.

International congress on NeuroRehabilitation and Neural Repair: Maastrict. Invited presentation and poster.

Health Hackathon: Health Enterprise East and Eastern Academic Health Science Network: University of East Anglia. Keynote speech.

Norwich Science Festival: The Forum. Norwich. Demonstrations – https://twitter.com/twitter/statuses/926427740475191296

UK Stroke Forum Conference: UK Stroke Forum. Liverpool

Spreading Improvement:

We will be seeking funds to spread the improvement initially through the eastern region. We are also working with collaborators at the University of Ulster to explore a test-bed site in Ireland. We expect culture and infrastructure to be different to our current site but have been working to spread knowledge of the innovation through professional colleagues and networks such as the Association of Physiotherapists interested in Neurology (ACPIN). We have formed a local collaboration with ACPIN east to develop Movement Technology – a strategy paper outlining this collaboration has been submitted to the journal 'Physiotherapy'.

To date we have had significant support for the innovation we have developed but we are now mindful of the further investment that will be required in order to sustain it.

Upcoming activities:

Workshop to be held in Jan/Feb 2018. We are organising two workshops in January/February 2018. We will be inviting therapists from the region interested in working with us to spread the development of the app. The second workshop will be for service users also interested in the same. The aim of these workshops will be to inform the development and design of a subsequent trial to gather both efficacy and cost data.

We will be submitting an abstract to the conference held by ACPIN in 2018. This will be highly influential in terms of gaining support from our peers.

Personal grant application for Dr Kathryn Mares (April 2018) – NIHR/HEE funded Integrated Clinical Academic Programme. This grant application supports an individual to further their research learning. The aim of this Fellowship will centre around the implementation of the new innovation (webapp).

Appendix 1: Resources and appendices

Example of one of the posters we have displayed at conferences.

University of East Anglia | SCHOOL OF HEALTH SCIENCES

FeSTivAPP – an innovative method for delivering Functional Strength Training exercises for the upper limb: a feasibility study

Living with Long Term conditions/Rehabilitation

Mares K., Gilbert L., Hodgson S., Bell S., and Pomeroy V.

Background

Stroke is a major health problem in the UK. Each year, approximately 125,000 people in England, 14000 in Scotland[1] 7,000 people in Wales[2] and 4,000 people in Northern Ireland[3] have a first or recurrent stroke.

There are around 1.2 million stroke survivors living in the UK[4]. The most common problem following stroke is weakness or complete loss of movement affecting one side of the body[5] .

The most important factor driving movement recovery after stroke is physical activity and lots of it[6]. Published studies have shown that during an inpatient hospital stay patients receive as little as 4-23 minutes a day of therapy targeting movement recovery of the arm[7]. Poor recovery of the arm leads to a greater dependence on carers for activities of daily living, social isolation and reported poor quality of life.

Therapists currently prescribe exercises as one method of encouraging the stroke survivor to carry out more activity with their affected arm. These are delivered through two-dimensional paper drawings, which are often insufficient and rely on the stroke survivor remembering the instructions and demonstration provided by the therapist. They are also not very motivating and can be easily lost in either the ward or the home environment.

Intervention:

A bespoke app (FeSTivAPP) designed to incorporate behaviour change techniques, showing videos of exercises which will be individually prescribed by therapists for the individual stroke survivor.

Study design:

A randomised controlled feasibility study with embedded qualitative investigation of participants' expectations and experiences of undertaking exercises via an App.

This study will be delivered in either the acute setting (inpatient), rehabilitation setting (inpatient) or the participant's own homes (community based setting) .

Correspondence: Dr Kath Mares; k.mares@uea.uk

Research objectives:

1.To understand whether FeSTivAPP is a feasible method of exercise delivery for stroke survivors and clinicians. To include:
- Adherence to exercise regime
- Willingness to take part in study/prescribe exercises via the app
- Usability of the app
2. To gain feedback from the participants and therapists with regards to features of the app to inform future development of any subsequent versions.
3. To estimate the probable recruitment rate and attrition to a subsequent trial.
4. To estimate the probable sample size needed for subsequent trial (effect size and response variation).
5. To evaluate outcome measures to determine the primary outcome measure for a future trial, to include responsiveness to change and potential for floor or ceiling effects.

Inclusion criteria:

1. adults aged 18+ years, diagnosed with stroke (infarct or haemorrhage)
2. presenting with an upper limb impairment and who would usually be prescribed an active exercise plan by therapists on the stroke pathway teams.
3. can follow a 1-stage command i.e. sufficient communication/orientation for interventions in this trial
4. able to access the material on the app – i.e. sufficient vision to be able to see the video demonstrations.

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