The following categories were composed from the semi-structured interviews with the participants.

**The role of technology**

Participants’ thoughts, feelings and attitudes were explored to understand the role that technology plays in their lives in general and in the rehabilitation of their stroke in particular. Although most participants were familiar with digital technology in some forms, the use of technology for the rehabilitation of their stroke condition varies as expressed by the following statements:

P3: I’m happy to use it if it’s going to improve my overall health. It has massive impact, it only makes things easier, quicker, to understand things, it’s very easy to ask questions for example on Google, if I have any queries, I can Google it and find out. I’m more than happy to use technology.

P8: I haven’t really used it before, the only time I probably used I would say it was during the lockdown of covid when there was sort of lots of exercises were available on television, on the iPad and whatever and one could access it very easily and I did do that, because it helped with the structure, it helped with the structure of the day, when I was saying this is what I turn on, this is what I do something, and it was directed, and it was also very professionally done of course these lockdown sessions, there was fresh things happening all the time, which kept one a lot interested. I was actually using from the television but using my iPad to use it on.

*Using specific criteria to match users to technology*

Users of technology should meet certain criteria in order to be able to use technology effectively. Users’ physical and functional abilities and their mental capacity would determine the level of use and acceptability of technology.

C4: I think it’s more useful if you’re more abled bodied, I think if you’re wheel chair or chair bound, they are not useful really.

C9: there is technology like … we did go to a disability gym, they tried to put my mum on a specially adapted wearing machine but it really wasn’t worth it because she’s very weak on the left side and those people were not familiar with stroke survivors so that didn’t work.

*Voicing reservations about technology*

Based on their previous experience with technology, some participants expressed their reluctance to use technology for their rehabilitation:

P5: Yes, I tried it [Wii balance] then I had a fall while using it which put me off using it. I used I Phone before stroke.

P7: I don’t like it.

C7: she [P7] doesn’t use a fitness app but I do, I use a fitness app on my I phone. Sometimes she presses a wrong button or something so I would do it with her. I don’t think you hate technology it’s just it’s difficult for her to press the right button sometimes and she might make a mistake or she worries about it but if I do it with her consent, would that be alright? Because some years ago for sometimes with remote control on the telly she wasn’t quite sure how to get to some certain things. … you [P7] have stopped using your phone, haven’t you? She [P7] didn’t use it that much before. Sometimes she can use it a bit but she can’t quite navigate with it.

*A preference for conventional rehabilitation methods (real therapist)*

Conventional rehabilitation methods where a real person provides therapeutic interventions were the method of choice for some participants. Some characteristics of face-to-face rehabilitation such as having an interaction with the therapist and receiving verbal feedback from them were stressed.

P10: I did use during the lockdown, there were Pilates lessons online and so I did use that sometimes. I think the thing is that where your laptop is and you’re trying to do things that the instructor is telling you but it’s … on a different level to what you’re trying to do, so, I suppose it’s quite good if you’ve got the face of somebody saying would you do this, would you do that, now we are going to do something else, yeah I think that’s good.

She (the instructor) was on the screen, if another person talking to you in teams or zoom I think if that’s possible that would be much better. To know if you’re doing the exercises properly and I think that would be the best thing if you have the real person in your home explaining to you.

**The nature of home exercises**

*Small and detailed exercises*

Compared with hospital exercises, home exercises are focused on achieving small goals through performing repetitive tasks over time.

C1: The home exercises are very small and detailed compared to the general progress that made with hospital who are going for much more bigger overall aims. At home we have been working on very tiny steps, with individual muscles and small improvement but gradually as those small improvements have occurred the overall picture gives bigger improvement. … they have been concentrating on repetition, so keep repeating until new things comes on and then keep on doing the same thing over and over again.

*Out of context exercises*

Home exercises are more likely to be standardised designed to improve the functional abilities of stroke survivors without having a direct link to activities of daily living.

P1: I didn’t find exercises I have been doing challenging, not particularly challenging. … P1: You found it difficult to see the improvement, don’t you? I’m not doing exercises to know things got better, I’m not doing things. I’m not doing other challenging physical activities, there is nothing there to test.

C1: they are out of context, the exercises are not applied to [activities] in real life situations.

*Practically challenging environment*

Carrying out home exercises has its own challenges. For example, finding the appropriate location in the house to do the exercises, the need for some equipment to assist with the exercises and choosing and following the right exercise programme.

P5: Yes, lots of good things about it, but the motivation aspect of it is difficult. It’s just difficult to get started, I went through a phase of feeling a bit low so you know that was even more difficult, once I started the exercise routine, I was ok, It was just that feeling … the environment is challenging.

C5: it would be better to have a definite plan and to record his [P5] progress, I think with home environment you just sort of floundering, you don’t know really what to do, and there are many different exercises to do and you don’t know what to work on, you are a bit overwhelmed, it’s better to have one thing at the time I think, the programme, I don’t mean one exercise. And because we wanted him [P5] to get better so much you just bombarded by them. … Positioning, the best position to do things, I know I’ve got the bed but sometimes it would be useful to have more equipment, you know weights and stuff like that and a bench would have been useful.

*Familiar environment*

However, being able to perform the exercises at the comfort of one’s home with having the flexibility to do it at their convenience is not only beneficial for the rehabilitation of the stroke but also will improve the general well-being and mental health of the stroke survivor.

P7: I like it because it’s home.

P3: I’m ok with that. After the stroke, I was shown by an NHS physiotherapist in hospital and then secondly when I was paying privately for it. For example, on the table pushing and pulling on a ball, for example, squeezing rubber balls, on the wall pulling elastic bands, rubber bands. I practise most days and to suit what I’m doing at home, whether I have visitors, I work round and I fit in where I could not specific routine.

P8: if you know something going to be at certain time or last for an hour or whatever, here it was the hour I would allocate for that. If you want to go back and do more that’s fine but I had put a structure on that and say I might say this is my exercise time and it’s easy to turn the tv on. My only problem is what I’m going actually to use to watch to get the guidance from to do it on the technology because I use only one hand and sometimes you can’t both hold and move something. … The benefit is not specifically about the stroke issue but about general ageing and it’s good mentally as well because actually you’re doing something.

*Motivational aspect of home environment*

Some participants felt that stroke survivors need to be encouraged by someone to be able to perform the exercises regularly. The role of a family member or a therapist could be motivational for stroke survivors to continue with their exercises and to observe their progress.

C9: you need really another person to help, unless the stroke survivor is incredibly motivated, you need families and loved ones to help with that, and you know the initial stages when you have community therapy and if you develop something, you get a physiotherapist or a rehab support worker to work with you on, in that initial hospital discharge to community section, an enablement section, if you can get both kind of professionals involved in it then that work because they are going to do it with the person, then kind of incentivising the patient to continue on with then that’s great, otherwise you really have to incentivise the family members of anybody … you can’t incentivise care workers because trust me it doesn’t work.

P10: It’s a very good thing, when I had my stroke, the physiotherapist came out every week or couple of weeks and checked how I was doing, gave me new exercises, and I did do the exercises at home, yes because at that stage I was so unable to do a lot of things and I did very much need the strength. But also, what was very good was that she was checking up on me and kind of I knew that I had to do the exercises to get the progression so when the next time she came there was some progress, and I think that’s very motivating. And also, the thing not to let her down.

*Personalised rehabilitation tailored to needs and preferences*

Home exercises should be tailored to stroke survivors’ circumstances and life goals. The focus should be on their preferences and their adaptation mechanisms post-stroke.

C3: when I came in, he was more interested in and wanting to learn to walk properly, that was his main thing, I know he’s lost the use of his left arm and his left leg but he found if he could walk that would be a big plus for him instead of being pushed in a wheel chair and that became his priority. That’s why since Christmas we are going outside walking and walking. I think he would give up his arm if he’s got his leg, that sort of the situation if you know what I mean. Being able to walk, to go to town, get on the bus, to walk around was more important than to be able to pick up something with his hand.

**The nature of rehabilitation methods (real vs virtual objects)**

*The importance of social aspect of rehabilitation*

For some participants, the stroke rehabilitation has many dimensions including technical and social aspects where the latter is most likely to be met through real interaction with a therapist.

P1: Prefer real objects because it has nothing to do with rehabilitation but it’s got with social interaction.

P3: I can’t remember using anything like that [virtual], it was under the instruction of the community physiotherapist. Playing children games on the Wii machine, playing Tennis for example, which I found very boring to sit in front of my television screen, I thought it was a total waste of the session, I wanted more physical, I’d rather be outside walking for example, sat in front of the television screen playing virtual Tennis so that was the only one I can really remember. It wasn’t fun for me. I prefer real exercises, of course, absolutely.

*A matter of choice and preference*

Stroke survivors’ level of physical and mental capacity, their background and most importantly the changes they have experienced after the stroke can influence their willingness to opt for either real or virtual method of rehabilitation.

P8: I used to have before I had my stroke a Wii exercises and I used to enjoy those exercises, they were great fun, I’m not sure how I would feel doing those things now, I mean I don’t know I haven’t thought of that but perhaps that’s an option for one to use and that’s something that one needs to be willing to play with the technology.

P10: That’s another option. I don’t have any game box thing but I suppose depending what the thing they are trying to get better is if it’s given to them and explained and again, I suppose it might … I’ve heard people using really taken by these games and getting quite success by getting to the next level so that would be a good option. But I suppose you’re talking about the physical, I’m just thinking about the mental capacity of working it out, I suppose everybody is different, what it is they are trying to improve, or need to improve, and I suppose it should be a reporting back system so you would know what was happening you know, how often they are using it and what the results are, that sounds fun and also probably for younger people you know they might like that.

**Essential features of technology-assisted home exercises**

*Ability to monitor, record and assess progress*

The most important feature of any home exercises driven by technology is the ability to oversee the process of rehabilitation including setting the goals, recording the process and the outcome, providing feedback on the performance and the outcome and evaluate the overall progress.

P4: when I go every week, they record what to do every week so I can see how much I’m building up. If something that could monitor how you are going on each day so you know you can compare how you were previous, some form of data.

C4: I think if you’ve got feedback, and it’s positive, it gives you more incentive, more motivation.

P5: it would be an App; it would record what I’m actually doing and then the next time when I use it a bit of motivation to increase the score.

C1: it would be nice to have target because I filled that, exercise log but I’d like a progress sheet or some way of giving feedback on progress for each of the little things that he improves on, for example, when P1 started to move his arm and now he can lift the cane.

C9: If you had ten sessions, I would check in with the person off the session 4, session 8, session 10, see how far they’ve got, do they feel like that they have made any progress, in session 4 if they’ve made progress and they are still motivated, if there is anything you need to change, what is it that you could tweak, it’s about achievement, isn’t it? It is such a big shock for lots of people, the stroke survivors, and the people around them, but if you create little achievements, it sort of boosts them so much that then they can move on to other goals, and they feel they can do other things with their lives.

*Simplicity*

The need for simple technology was stressed by some participants. Technology should be simple in terms of structure and functionality, if there is an interface, the content should be comprehensible without technical jargon, easy to navigate and visually aesthetic.

P8: for me it’s going to be actually simple, I don’t want … simple both in what’s I’ve been asked to do but also simple in the language it uses and simple in presentation. It can’t be something that I have to do lots of actual alterations to the platform I’m using because that’ hard again. I think Videos are very good.

*Independency*

The use of technology in delivering home exercises is associated with assigning stroke survivors some degree of agency and control in the rehabilitation of their stroke and sharing responsibility in the management of their condition. This concept is evident in the account of some participants.

P1: I like the exercises that I can do totally independently, unsupervised exercises. C1: If he wants to do the exercises independently, would it be useful to have some way of recording to show you have done them.

*Useable, acceptable and engaging*

Stroke survivors’ physical and cognitive abilities and their digital skills have a direct impact on the usability and acceptability of technology. The technology should be personalised so it could be responsive to a range of users with different individual needs and preferences.

C9: So, if you were to do anything in terms of upper limb you need to understand stroke survivors better, what they are capable of doing, what make them tolerate, what kind of spasticity they’ve got in their upper limb, and their concentration level, my mum concentration’s level is about 20 mins maximum, (sever stroke), and if you want to engage them. If they are not going to be motivated and concentrating, you’re going to lose them quite quickly and you want to kind of gain their trust. So, I definitely would see what’s working and what’s not working in terms of engaging those patients, so is it a carer wants them to do it or do they want to do it? What would I get out of it you know?

P10: I don’t know really how to make it fun. Because if you’re doing your exercises on your own, you just do them. I suppose it’s the thing that if you’re doing at home or if you’re doing it in a group. I think some devices have a way of bringing in you know other people doing it at the same time and I mean I’ve seen again going back to during the lockdown, when there was a Pilates class and the instructor was in the big picture but you could see everybody else doing their hands and doing their legs and everything.

*All-in-one rehabilitation system*

A compact system that is easy to use and operate without the need to be installed and assembled every time, would appear more appealing to users.

P8: one thing with technology timing would be a good idea, if one can set it on a time to do it that would be quite useful. I could have done it with anything, I could have used the cooker time but I haven’t, and I think that’s the other thing if it’s all together in one place, and the technology has those things to facilitate you, I think you’re more likely to use it, all is needed is to time yourself, you still got to assemble the bits and pieces whereas actually when you have your assembled iPad that’s all you got to look at, that’s all you got to play with so in-built sort of timing mechanism would be good as well.

*Goal-oriented exercises*

Home exercises should be designed based on a goal-oriented rehabilitation programme where goals are negotiated with the stroke survivor, set, planned, reviewed, revisited and achieved over a specific period of time.

C9: the way they are supposed to do it now is person-centred. What they do they stay focused on the goal, for example, somebody would want to go to the shops because they like shopping, how would you break down all those things, you have to get dressed, you have to get everything ready, you have to get your bag ready, how you are going to get there, how you’re going to walk or how you’re going to operate a power-assisted chair, you have to break down that massive goal of I want to go shopping into little functional goals and bizarrely they are assisted daily living kind of goals, they are well-being goals and mental goals, and they are all combined into that. … That kind of things, you would break it down into little goals and that’s probably you’re right, that would motivate to continue those with technology because the technology can help them to reach those small steps.

*Providing feedback*

Feedback on performance as well as on the outcome of exercises over time can increase users’ motivation to achieve their therapeutic goals which could potentially lead to achieving their life goals. Life goals can be periodically reviewed and modified based on the feedback.

P2: I know if I have done the full time [on the bike] and I know it I’ve improved the distance so I speed up but it doesn’t pat me on the back and saying well done.

C2: there is no point using pedometer when walking with P2 because it doesn’t register his steps and because I’m not making impact in the same way it doesn’t record how far I’ve gone either. So, literally we work out where we want to go, if we decide him to go a bit further then I count the extra amount. And I’ll tell him how many steps he has done.

P3: If there is any way that you could tell me that either a) I’m improving or b) going down, anything that would guide me and let me know if I’m going in the right direction, improving my mobility. On a scale of 1-10 or A-Z, such as weekly feedback. To boost the motivation and confidence, I want to see that I am improving. I am willing to try anything but it must be positive, I don’t want to go through something just for the sake of computer and app, I want to know it’s doing me some good.

P4: when I go every week, they record what to do every week so I can see how much I’m building up. Data is good enough.

P5: to give you a bit of motivation for progress, e.g., numbers of reps, times, any measurements that you can see the improvements, both recording after wards but also while doing the actual exercise.

P8: I think one way that I test out it is actually trying to do some of the exercises I have been doing in real life situations, so I mean in the kitchen doing something, can I reach further, if I have been practising something which it means reaching and leaning, can I reach and lean? I have been practising something where I have got to balance for longer, stand still for a period of time, can I do that? Having a base test and then having a later test, I don’t know, I don’t have that kind of technology that can actually give me feedback on what I’m doing. … when you’re working with a physio, your physio saying: stand up straight, keep your hips in line and you don’t know and of course you’re trying to do that, that’s what you’re meaning to do but in fact you’re not doing it, you need someone to tell you, perhaps technology can help you with that.

C9: in terms of people’s motivation, it would be good people around them and have a follow-up session with you, or whoever overseas that kind of work. Also, when you create technology and it gives you feedback in terms of … if you had a voice that said you’re doing great, you’re leaning to certain goal or you have it in symbols encourages you to keep going, you’d be surprised how much motivation is key in stroke survivors’ rehab. Believe me it’s a long process, it requires a lot of incentivisation.

P10: The best is the real person one-to-one, if there is some way of, if every now and then having an in-person coming to the house, I think that’s the very best. I think for when that’s not possible if there is slot when you know that they are going to get in touch with you, I think it’s the relationship building, it’s not just doing the exercises, feeling that there is somebody there who actually mind whether you’ve done it or not and I think that’s a good motivation. Some people like to do it through text messages but I think that’s not so effective.

Some people might like graphs and numbers, I can imagine some people might but I personally not bothered. I would more react to somebody caring if I have it done or not and encouraging me to do it. But some people might like graphs.

**Envisioning possibilities**

Participants were encouraged to use their imagination coupled with their lived experience of stroke to envision design and innovation possibilities that inform and inspire the direction of stroke home rehabilitation.

C2: something that would help him [P2] stretch his fingers, something to help with grasping, gripping, releasing and holding the weights.

P3: I would expect it would help me to start using my hands little bit more normally and also walking more easily and normally. That’s I would expect from technology.

C4: To do home exercise, you [P4] do need some form of machinery, like if you had a DVD or Video on exercises to try to follow, you still want to move that leg, you need something. If he [P4] got a video showing him how to do, he can do sited exercises probably but still wouldn’t help him move his leg, if there was somebody there making him do all these with his leg, he still wouldn’t be able to do it, he needs some form of machinery.

P5: it would be an app so you could use on the T.V to take you through the programme, I have done that on the form which is a bit small to see but when you’re actually doing the exercise something on the T.V would be better.

P7: Something that makes my hand more functioning, more confident to use the affected hand, and using the stick.

P8: Something that make my thumb to move because I can bend the fingers and they would grip but when I’m gripping, I’m not gripping with my hand, I’m gripping with my fingers, my fingers would do something but the hand won’t.

P9: If you could get a glove that could allow her [P9] to assist her to grip that would’ve been perfect, that would have allowed her to move and even with that affected hand to hold a glass and drink from it independently, that would have done so much for her well-being as well as just physical element and if you did something like that that would be outstanding.

**Temporal comparison (pre- and post- stroke changes)**

The experience of physical and cognitive changes following the stroke has made participants to modify their life goals that are not attainable anymore. By identifying more realistic goals, they can link them with customised home exercises and self-manage their stroke more effectively.

P1: activities before stroke: hill walking, fine finger skills, holding newspaper, cooking, decorating, holding (grandkids) and physical contacts. [activities after the stroke]: I don’t really know, to be able to walk outdoor, start cooking again.

P2: I can’t do press up, can’t do any rowing, can’t do any lifting, I can’t do any of those anymore around the house and driving.

C2: he [P2] can’t dress himself, he can do in the shower a bit of washing himself but there are certain things I have to help with.

P3: recreation wise, any sport, I used to play cricket regularly, playing football, all sports has got out of the window, I used to go swimming occasionally when I was on holiday, I haven’t even been near swimming pools. Daily activities, cooking for example, I used to cook more or less everyday not just for myself but for me and my partner for example, because it takes me so long to walk to the kitchen, more or less I have stopped doing it.

C3: it’s not about so much walking around, it’s opening things, opening packets, closing them again, if I give you a packet of something and ask you to open it with one hand, it seems that sort of things I’m talking about and if I say to you if you don’t seal it, it’s gonna go off and it’s very difficult… but I don’t do everything for him [P3], I let him do certain things during the day to keep him active.

P4: it’s everything really. I can’t drive and the only job I was doing [before the stroke] was driving. I can’t sit anywhere without getting uncomfortable whereas before you just load yourself about, I find that difficult to do.

C4: you [P4] can still write, something as simple as eating, you can’t use one hand, you get people to cut meal up for you, you can’t go to the toilet. He [P4] also leans to the left because probably that’s heavy, that’s side is heavy.

P5: anything involving grip, writing, eating, using a keyboard, dressing, showering, gardening, driving.

C5: simple things like washing, it’s just everyday living activities.

C7: she [P7] was very active and she used to enjoy walking sometimes with me, a couple of miles, and she used to enjoy going for a swim, she stopped a few years ago because of her ear infection, but she used to swim a lot and she cooked every day, doing all the normal tasks, doing the washing and ironing, she used to drive and that’s very frustrating because she can’t go and see her friends, of course it’s also tied up with her voice, she’s got a bit more confident, haven’t you?

P8: Mechanical things like operating in the theatre I was operating sound desk or lighting desk, now I can still do lighting desk with one hand but it would be incredibly slow so a lot of it is about the slowness of doing a task. One of the things I had to do with stroke was to desperately trying to learn patience … but it hasn’t been easy. There are a lot of things I can’t simply do, I can’t climb a ladder, it’s got to do with aging anyway but it’s slowing down, dividing the task into pieces if you like. And also trying to get the weak hand doing it.

P10: Well, it’s been more than 10 years and I have been hugely hugely lucky, I mean really, so I think I’m ok on my daily activity, I just have to pace myself in terms of speech really, and I kind of learned to pace myself. I’ve been able to go back to work and my boss when I first went back was absolutely lovely, … When I first after my stroke and I couldn’t pick up the phone and I couldn’t understand telephone numbers you know, and actually I wasn’t able to type but no, I can’t really talk about activities of daily living that I can’t do except just tiredness but I have been more that lucky.