

Integrating a Unique Leg Strengthening Device (S-Press) into Physiotherapy Rehabilitation Practice, a Qualitative Examination

Kate Walker^{1*}, Chris Griffiths¹, Bharath Lakkappa²

¹Research and Innovation Department, Northamptonshire Healthcare NHS Foundation Trust, Northampton, UK

²Consultant/Clinical Director Community/CECS, Northamptonshire Healthcare NHS Foundation Trust, Northampton, UK

Email: *Kate.Walker@nhft.nhs.uk, Chris.Griffiths@nhft.nhs.uk, bharath.lakkappa@nhft.nhs.uk

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Abstract

Muscle deconditioning due to hospitalisation is problematic, causing delayed discharges, more nursing, carer, or social service support following discharge, and possible discharge to a care home rather than the patient's own home. Muscle deconditioning is associated with increased mortality, infections, depression, and reductions in patient mobility and ability to engage in their activities of daily living. Preserving muscle strength and function should form part of patients' rehabilitation plans. Progressive resistance training (PRE) offers the most cost-effective way of preserving muscle strength and function; however, it is not routinely carried out in hospitals. A leg strengthening device (the S-Press) has been developed with the aim of improving access to effective PRE for adults. Using a qualitative approach, thematic analysis of interviews with physiotherapists, patients, and relative carers about their experience of using the S-Press provided insight into integrating PRE into patients' rehabilitation, what promoted or prevented its use, and the outcomes associated with its use. Four overall themes emerged from the data. "**Experience of Users**" described that the S-Press was accessible, convenient, time efficient, portable, and manoeuvrable, and it provided an objective measure of progress. "**Facilitators**" included findings around how the S-Press was easy to use, motivational, and comfortable when in use. "**Barriers**" comprised the inability of some patients to use the S-Press independently and the identification of obstacles that prevented consistent use. "**Impact and Benefits**" represented the perceptions of increased leg strength and psychological benefits. The S-Press is beneficial for patients' rehabilitation by offering PRE that is simple and easy to use, acceptable to both patients and professionals, and can be integrated as part of patients' rehabilitation plans.

Keywords

Physiotherapy, Rehabilitation, Strength Training, Deconditioning, Resistance Training

1. Introduction

Current UK hospital bed occupancy is 93%, yet it is reported that a safe occupancy level is 85%, meaning there is a requirement for 9353 more available beds to achieve this safety criteria [1]. Lack of physical mobility can cause delays in discharging patients, and this applies to a greater extent to older people as they are often frail and have complex mobility, social, and healthcare needs [2]. Two causes of delay in discharge are physical deconditioning and slow physical recovery [3]. Delays in discharge are costly to the UK's National Health Service (NHS), with direct costs of delayed charges alone (excluding additional costs from other activities such as cancelled and/or rescheduled operations and staff time organising care packages) being estimated at £1.7 billion [4]. In addition, delayed discharges have been associated with increased mortality, infections, depression, and reductions in patients' mobility and ability to engage in their activities of daily living [5]. An increasingly older population presents with a range of multiple pathologies and long-term illnesses (e.g., dementia, heart disease, diabetes, cancer, kidney failure), which increases the length of stay in hospital and so hospital-associated deconditioning [6] and coupled with a lack of availability of social care, and intermediate care capacity only meeting approximately half the demand required [4], raises the importance of preventing physical deconditioning due to hospitalisation. Finding solutions for preventing physical deconditioning due to hospitalisation is, therefore, a priority of the NHS and other country's healthcare systems.

Hospital-Associated Deconditioning (HAD) is where there is a complex negative mobility consequence because of hospitalisation [3]. Prevention of HAD is a priority healthcare unmet need; there is a high risk of its occurrence, given, for example, around 10.5 million vulnerable older adults (*i.e.*, those in need of special care, support, or protection because of their age) (65+) were admitted into UK hospitals in the annual period 2020-2021, with those aged 65 and over accounting for over 40% of admissions, and occupying approximately 66% of hospital inpatient beds [7]. An impact of hospitalisation for older patients is a decrease in muscle mass and significant functional decline [3]. Although associated with long-term hospitalisation, the muscle deconditioning process begins within 2 days, with baseline strength reducing by up to 20% in 1 week; 68% of patients are discharged below their pre-admission level of functioning [8] [9]. Deconditioned patients are three times more likely to be re-admitted within 30 days of their discharge, with deconditioning also being associated with 47% of delayed discharges [10].

Physical inactivity is associated with medical complications and physical deterioration for individuals regardless of their age [11]. When individuals have no or

low mobility during a spell of hospitalisation this is associated with decline in activities of daily living and increases in institutionalised care requirements and mortality [12]. A key issue associated with bed rest or low to no activity is a significant loss in skeletal muscle mass, which then accelerates a decline in physical mobility [13]. There is a 2% to 5% decline in muscle mass per day when a patient does not walk or their legs are inactive [14], and immobile patients can lose 10% of their muscle over a seven-day period [15]; older adults are even more vulnerable to having a negative impact on their muscle strength and mass following hospitalisation [16]. Reduced muscle mass and muscle fiber size can lead to up to 40% reduction in muscle strength within a week [17]. Structured exercise programmes applied early during hospitalisation can prevent muscle function deterioration and reduce functional decline, reversing the trend of the impairment of patients' functional ability during activities of daily living associated with acute hospitalisation, and have benefits on cognitive status and quality of life [18].

Preserving muscle strength and function should form part of patients' rehabilitation plans and is where physiotherapy can have a key role. High-velocity/low-load resistance or muscle power training improves muscle strength [19]. A single-blind randomised clinical trial found that an intervention that emphasised muscle strength training was effective in improving lower limb muscle power output and muscular strength for older hospitalised patients [11]. Resistance exercise is utilising resistance (e.g., body weight, free weights, resistance, bands, machines, etc.) to improve muscle strength [20]; progressive resistance exercise (PRE) is where "participants exercise their muscles against some type of resistance that is progressively increased as their strength improves" [21]. PRE has been found to increase muscle strength even for individuals who are particularly frail [13]. Older adults can achieve similar gains to younger individuals with PRE training, where substantial adaptive plasticity in skeletal muscle and the neuromuscular system has been demonstrated [22]. PRE has been found to be safe, acceptable, and well-tolerated in older post-acute inpatients who require rehabilitation [23]. PRE should be used more in hospitals to prevent deconditioning, improve muscle strength, and in doing so, improve rehabilitation outcomes [9].

The benefits of using PRE have been well documented (for a review, see [21]), yet physiotherapists working in hospitals don't routinely use it [9] [13]. Barriers can include institutional-related barriers, changing demands for physiotherapists within the NHS, lack of appropriate equipment, and time pressures [24] [25]. Other barriers identified include perceptions by staff of poor patient capacity to use PRE, a lack of confidence in using PRE as an intervention, and restricted and limited access to equipment [26]. In a recent study [20], the authors found that few physiotherapists used or prescribed resistance exercises for older adults in acute care (34%). The greatest barrier identified was a lack of prioritisation of resistance exercises among other duties, whilst other barriers comprised: perceived poor patient motivation, the belief by staff that some patients were unable to perform resistance exercises, a clear lack of definition around resistance exercises, and insufficient

support personnel for effective implementation [20]. There are also barriers that exist in relation to providing physiotherapy generally as part of inpatient rehabilitation, such as patient fatigue, patient dependency, patients feeling weak, unwell, unstable and anxious, pain, and pressure sores [24]. Patient barriers include low in-treatment adherence with exercise, low self-efficacy, depression, anxiety, a greater perceived number of barriers to exercise, and increased pain levels during exercise [27]. From the professionals' point of view, barriers to being able to implement PRE include a lack of available equipment and physiotherapists' time constraints/workload [28].

There is a lack of PRE equipment available for physiotherapists, and its use is further compounded by low clinical staff numbers and time availability. To remedy this, a new portable leg strengthening device called the Strength-Press (S-Press) has been designed by a physiotherapist with the aim of improving access to and availability of effective PRE for vulnerable adults. The S-Press allows appropriate patients to use the S-Press independently once set up. The device was designed to be easy to use from a professional and patient perspective, offering an effective mode of PRE [29]. The S-Press is designed to remove barriers to effective rehabilitation; it is portable, easy to store, simple to use, safe, and easy to set up; it can be used by patients who are weak, frail, anxious, and in pain; it has been designed to provide PRE for leg muscle strengthening [29]. The S-Press has been offered in a range of hospital settings in the NHS, and the aim of the current study is to qualitatively explore and understand how the S-Press is best integrated into practice, how patients and staff use the S-Press (and the barriers and facilitators) and its perceived benefits.

2. Design

A qualitative research design with one-to-one semi-structured interviews was undertaken with healthcare professionals, patients, and relative carers of patients to ask about their experience of using or supporting the use of the S-Press as part of individuals' physiotherapy rehabilitation plan.

2.1. Ethical Approval

Approval for the study was gained from the NHS healthcare trust, on which the services were based (reference number: IF: S-Press). All participants provided informed consent. The study was delivered in accordance with the declaration of Helsinki.

2.2. Participants

In total, 18 participants were recruited, who were either professionals who had used the S-Press with patients, patients who had used the S-Press as part of their rehabilitation, or relative carers of patients who had supported and observed patients using the S-Press. For the patients, inclusion criteria for the study were: any NHS inpatient admitted onto a ward site, assessed as medically stable and physically

able to participate, and able to provide informed written consent for participation. Exclusion criteria included any patient unable to give informed consent, significantly confused patients, or those unable to do leg press exercises. In addition, there were certain medical exclusions: those who were unstable or with deteriorating medical conditions, acutely unwell with an infection, undergoing treatment for cancer, or with high blood pressure that is uncontrolled. Of the participants, 9 patients were recruited: 6 males (66.7%) and 3 females (33.3%). The age range of participants was 47 - 93 years ($M_{age} = 74.44$ years, $SD = 15.61$). Length of stay in the hospital ranged from 7 weeks to 35 weeks ($M_{stay} = 18.22$ weeks, $SD = 10.17$). All participants reported ethnicity as White British. Reasons for hospital admission included: broken leg; myocardial infarction (MI); vasculitis and ulcerated legs; cellulitis; hemiplegia and ataxia (following serious road traffic accident); right-hand side paralysis; shingles, pneumonia, Clostridium difficile (C. diff); head injury and loss of the use of lower leg (following fall) and; breathing difficulties and blood pressure problems. Two relative carers were recruited; both were wives of male patients (one hospitalised for infected total knee replacement, the other following cerebral vascular accident [CVA]), who met the criteria to participate but were unable to be interviewed (one subsequently deceased, the other found it difficult to speak following their CVA). Seven physiotherapists, five females (71.4%) and two males (28.6%), were recruited based on the inclusion criteria that they had regularly used the S-Press with patients. Length of time as a qualified physiotherapist ranged from 3 months (0.25 years) to 19 years ($M_{years} = 8.87$, $SD = 7.75$).

2.3. The S-Press

The S-Press™ weighs 7.3 kg and is a portable leg-strengthening device; it is a Class 1 medical device. It offers 3 - 29 kg of therapeutic level resistance across 6 easily changeable levels. By using it in one direction, it targets the quadriceps, and it can be rotated to target the hamstrings specifically; it is a gym equivalent leg press and hamstring curl device in one unit. The S-Press can be used by a patient who is recovering from illness or injury, who needs to maintain their muscle function while they are healing, and to prevent the damaging effects of muscle deconditioning. The S-Press has an interchangeable supportive leg rest and flat footplate for use on the bed, in a chair, or in a wheelchair, allowing patients to choose what is most comfortable for them to use.

2.4. Data Analysis

The data were analysed using thematic analysis (TA) as informed by Braun and Clarke [30] [31] and followed their six-step process. All coding was done inductively, and themes were developed at the semantic level. The six-step process followed is presented in **Table 1**.

The principles of credibility, transferability, dependability, and confirmability were followed as informed by Korstjens and Moser [32], alongside the guidelines by Shenton [33].

Table 1. Process of TA implemented.

Six step process	Process implemented
1) Familiarisation with the data	Data were transcribed, read, and re-read, and initial codes noted
2) Generating initial codes	Interesting features across the data set were coded, and data relevant to each code collated
3) Searching for themes	Codes were collated into potential themes, and data relevant to them gathered
4) Reviewing themes	Themes were assessed, combined, refined, separated, and discarded accordingly
5) Defining and naming themes	Operationalisation of each theme and subthemes and development of clear working definitions that capture the essence of each theme
6) Producing the report	The overall learning from the qualitative data analysis was written up, summarising the themes and illustrating these with noteworthy quotes

3. Results

The themes that were inductively developed from the interview data were grouped into four global themes. The global themes were labelled as: Experience of Users, Facilitators, Barriers, and Impact and Benefits. The global themes and their associated themes are presented in **Figure 1**.

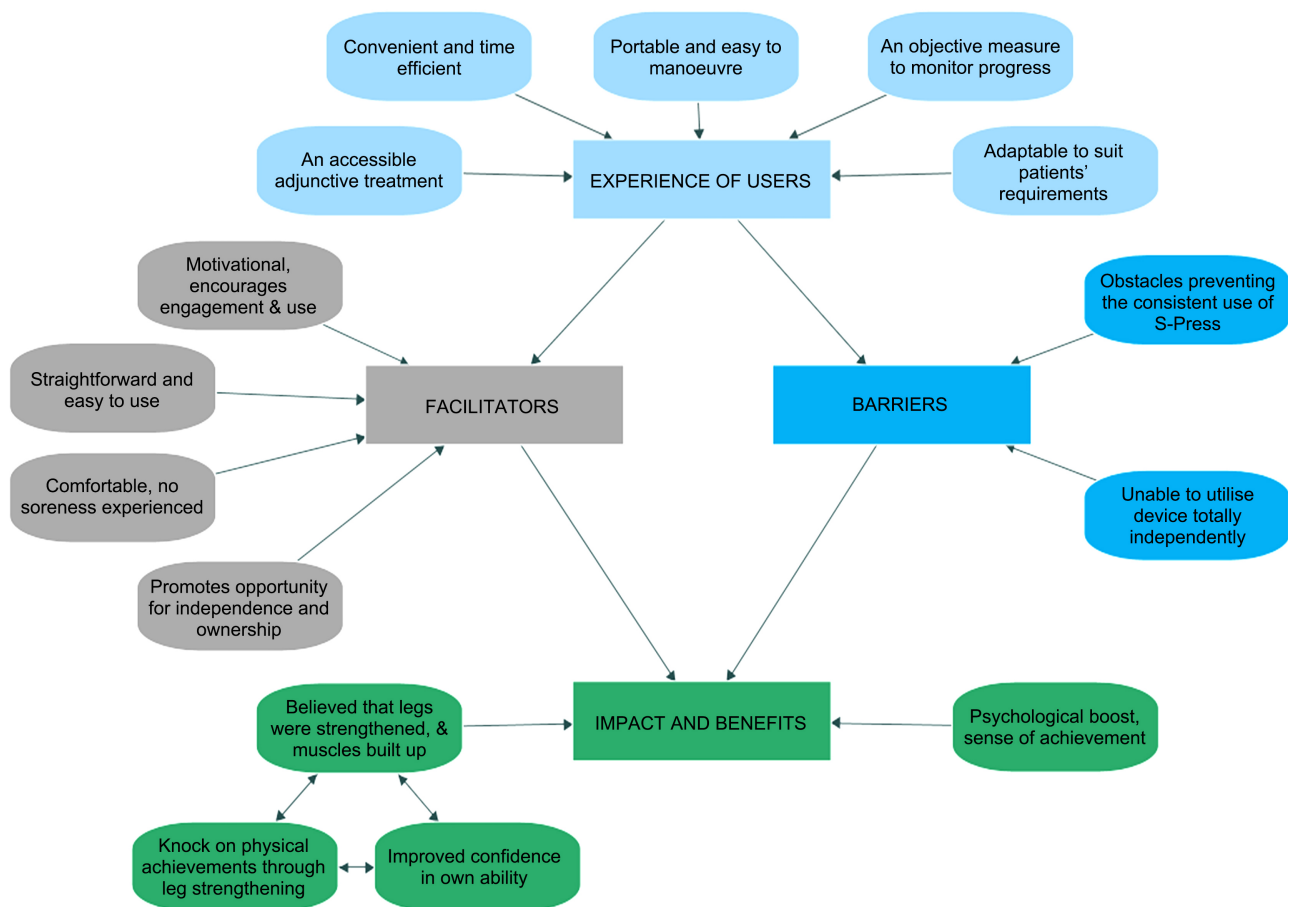


Figure 1. Global themes with their associated themes.

A description of the themes follows, with supporting quotes from the interview data. These are presented verbatim, as spoken by the participants themselves. For reasons of anonymity, participants were given a unique code. All patients were assigned the letter P followed by a number, relative carers a R followed by a number, and physiotherapists a S followed by a number.

4. Experience of Users

This global theme is made up of five themes, all of which represent different aspects of the useability of the S-Press. This is the experience of how the S-Press is used by physiotherapists and patients and its integration into patients' care and rehabilitation.

4.1. An accessible Adjunctive Treatment

The S-Press was seen as something that was accessible, user-friendly for the physiotherapist and the patients, and enabled treatment and input where other approaches and interventions perhaps would not be accessible, e.g., equipment in the gym or a motorised cycle device.

S1: The closest thing would be like a sort of type of motorised cycle device, but those tend to be really static. So sometimes we can't get the bike to the patient. So, it's good that we can bring this [S-Press] to them, rather than having to go to like a therapy gym or kind of leave the ward.

The S-Press exercises were done in between physiotherapy as an adjunct. As well as being used as part of formal rehabilitation by physiotherapists, it can be implemented in between formal scheduled sessions, including at the weekend, when physiotherapy is not always available. As a device, it is accessible to be used by different professionals at different times.

S2: It's like is an adjunct to physio, it's a good way of adding more therapy for the patients... being able to be used with sort of assistant staff or, or ward staff... it gets used quite a lot as well over the weekend.

4.2. Convenient and Time Efficient

It was found that the S-Press was convenient to use and something that could easily be implemented while patients were sitting in their beds, meaning both the patients' and the physiotherapists' time was being used efficiently and effectively.

P1: Well, the machine is a benefit to you because you do it laying in bed, doing it, you're not doing anything else, so you might as well be doing that. You are not taking up a physio's time.

From a practical point of view, the S-Press was not as time-consuming as other forms of therapy, thereby providing the resistance training required in a time-efficient manner.

S3: It wasn't as time consuming as the bikes. The bike tends to be 15 minutes.

We could do the S-Press 5, 10 minutes it was done, they'd done both legs.

The S-Press could be easily integrated into rehabilitation and used with several patients concurrently. In some instances, it was used as part of a circuit, meaning it was convenient, time efficient and enabled the physiotherapists to treat several patients at the same time.

S7: Time wise, it was great because we could bring several patients to the gym and have one patient doing their leg strengthening while we're doing standing balance or mobility with another. Then they could swap over, so it was really helpful like that.

4.3. Portable and Easy to Manoeuvre

Words used to describe the S-Press included “*Compact*” [P3, S2]; “*Portable*” [S2, S3, S4, S5]; and “*Easy to manoeuvre*” [S4, S7]. As such, this enhanced its useability. The S-Press was found to be something unique that could replicate and so replace other less portable and less manoeuvrable equipment that some of the patients couldn't access.

S3: It's having a mobile piece of equipment that can replicate a large piece of equipment in the gym, has been handy, it's unique within the healthcare setting. There's nothing close to it.

In practical terms, its size, its mechanics, and the fact that it is not an electronic device with an array of cables and plugs added to its appeal and usability for staff and patients alike.

S1: It's not huge in terms of size, it's quite compact. So, not lugging in a massive machine or anything on wheels that you've got to set up and plug in and stuff like that. So there's no kind of cables or any bulky parts to it.

4.4. An Objective Measure to Monitor Progress

One of the features of the S-Press, liked by the majority of the patients, relatives, and professionals, was that it could be used to monitor progress, and it gave an objective measure of this. One of the patients described how it was a measure of the effort that they were putting in, providing helpful visual feedback.

P5: With the motorised cycle device if the screen wasn't on, it was just doing it for you... you weren't really quite sure how much you were putting into it. Whereas you get that real visual feedback, I've gone past the line as well.

One of the relatives also commented on the benefit of being able to chart progress; from their perspective, they felt it was easy to see any progression being made based on the numbers of levels and repetitions of exercises achieved.

R2: You can chart your progress. It's nice having something that counts for you, you can say yesterday I did 50 reps on level 2 and now I can do 100 reps or I can go up to Level 3... it's easy to see the progression.

Across all the narratives of the physiotherapists, there was reference to the S-Press being an *objective* outcome measure that can be used to monitor and clearly see improvement and progression.

S2: The strength is it is very much like an outcome measure. I mean it's very clear that the person starts on this, they can start on that level, they've done that amount of reps and you can see the clear improvement. You can objectively see that.

4.5. Adaptable to Suit Patients' Requirements

The S-Press was adaptable in its positioning, so it could accommodate the requirements of each patient. For example, some of the patients required something that could be used while in their bed:

P6: But I found it brilliant because you could exercise your legs whilst laying in bed. And when I, initially when I was admitted, that's the only thing really I could do. I couldn't, I could hardly get out of bed, I couldn't walk anywhere.

However, others needed something that could be used in a seated position:

P3: Well, I was sitting in my riser recliner chair. And then they asked me to put my foot out and place it on the plate, which was sticking up... but they offered to do both legs... I could just sit there and do that, because I wasn't allowed to get up.

The S-Press has different foot plates that can be used, so these can be chosen, adapted, and set up to suit individual patients.

S7: The more elderly patients they did have quite good dorsiflexion, so they were finding that they prefer to use the padded blue boot. Up on the stroke unit, the patients, because they don't have the active dorsiflexion, they can't use the boot because it's moving, so they prefer to use the foot pedal, the firm one.

5. Facilitators

The narratives of the participants revealed what facilitated the use of the S-Press and encouraged and enabled the patients to engage with it. This global theme is made up of four themes.

5.1. Motivational and Goal-Led, Encourages Engagement and Use

This theme was widespread across the data set and found in the accounts of the patients, relatives, and physiotherapists. The S-Press motivated individuals by providing a goal to work towards achieving.

P2: It makes you focus, makes you feel better, then you've got something to work towards. It gives you motivation. With the motivation, obviously, it's making you feel better. You can push yourself and have a goal in mind, it's a

goal.

Linked to one of the previous themes around the S-Press offering an objective measure of progress, this worked to motivate the patients, encouraging them to use the machine more and strive for improvement.

R2: He's particularly driven by how many reps he's done and doing more today than he did yesterday. The fact that it's something countable and measurable has really helped this motivation. It was something measurable, that motivated him and was obviously measurably helping him get stronger.

Most of the professionals saw the S-Press as promoting motivation in their patients, which they identify as being something that can be challenging to do. This motivation came from the association of the S-Press with the improvements seen and felt by the patients; this, in turn, drives engagement with and motivation to use the S-Press.

S2: Getting patients motivated and feeling that they are recovering is a bit of a challenge. So, when they feel that they're improving on that, it adds to that motivation, it adds for them sort of really engaging with therapy, wanting to do more. You can see clear improvements; they can feel the improvements. It adds to that motivational factor.

5.2. Straightforward and Easy to Use

The S-Press is easy to use, uncomplicated, and straightforward to set up and use. Participants described it in these terms: *It was just straightforward, working my knee up and down, my legs up and down [P1]; It was pretty much self-explanatory, it was so simple [P2]; I found it very, very easy to use [P4]; So, it was very easy for both of us to learn how to use it, not complicated [R2]; It is quite straightforward user friendly, fairly simple [S1]; I think it is quite self-explanatory, it's self-explanatory [S4]; Well, most of them found it quite easy to use, so it didn't take a lot of explaining [S6].*

One of the professionals summarised well how the S-Press is a way for patients to easily and quickly be able to undertake resistance training.

S7: It's just the fact that it's such an easy way to offer resisted exercise for the lower limb, resisted strengthening, that we don't have at the moment otherwise. It's just so easy and quick and simple to use, so easy to set up, and the patients seem to manage it well.

5.3. Comfortable, No Soreness Experienced

A key factor that facilitated the use of the S-Press was that it was comfortable to use. Across all the discussions around comfort, the participants talked about how it never rubbed or caused any marking of the legs, with no redness, soreness, or skin breakage. No injuries were reported because of using the device.

P5: Really comfortable—it didn't hurt my leg or give me skin soreness or

anything.

R2: He's found it comfortable, it's not marked his skin or in any way harmed him.

The professionals reported that none of their patients complained of discomfort and that they never witnessed any skin soreness. The S-Press was far more comfortable than other options and was found to put less strain on joints.

S7: Well, none of them complained that it was uncomfortable. In fact, the opposite. Lots of patients were saying that it was much more comfortable on their joints, and that it was less strain on their joints than other options that we've got.

The professionals reported that in some cases, where patients already presented with existing sensitivity in their skin and legs, the S-Press was not problematic for them.

S3: It's really good in terms of getting the patients feet in, it's comfortable. So, some patients have a little bit of swelling, so they have quite sensitive skin and it's been absolutely fine with that.

5.4. Promotes Opportunities for Independence and Ownership

Assistance is needed with some patients through the set up and resistance control; however, once in place, patients found that they could be left alone to use the S-Press and do their physiotherapy.

P5: And I spent a lot of time with my bad leg trying to control it more, which was nice to be able to just do that without anyone else there, sort of on top of me to be able to do that independently.

Physiotherapists viewed this as safe, as did the relative carer, who identified that because of the way it could be used, it prevented other potential hazards from occurring.

R2: You can leave him to do it and come back in a bit when he's, when he's tired... you're not worried about him falling over.

This element of independence gave patients control over their physiotherapy and importantly promoted empowerment, ownership, and autonomy, all facilitating the use of the S-Press.

S3: The patient could be comfortable, within their limits, while advocating a bit of self-efficacy, so they could crack on themselves, and then feel a little bit more empowered. I think it gave them a little bit of self-autonomy, it gave them a bit of further exercise. I think it gave him [the patient] much greater control and autonomy over exercising.

6. Barriers

There were a couple of barriers associated with the use and implementation of the

S-Press, which were classified into two themes.

6.1. Obstacles Preventing the Consistent Use of S-Press

In some of the narratives, it was found that opportunities to consistently use the S-Press were missed: *It's just difficult to get the opportunity, the consistency to use it every day* [S4]. It was found that, for example, non-physiotherapy staff were reluctant to use the S-Press even though this is something they could easily learn to do. There seemed to be obstacles around non-physiotherapy staff, who felt they were not trained to use it, meaning the S-Press was not being utilised to its full capacity.

P6: The downside to [hospital name], they didn't train enough of the nurses or carers to use it. They were a little bit – 'Oh, what's that?' 'What do you do with it?' So, you didn't get as much use out of S-Press as what you should have. It's something that none of them got really trained on...but it was easy to use, but they seemed to be frightened of it.

Another obstacle was initiating and starting to use the S-Press and then building this in as part of rehabilitation and beyond formal physiotherapy sessions.

S2: I think the major barrier, it's not using it, once you're using it, it's fine. I think the major thing is getting it to the person to be used and how you do that and building it into your sessions, because you want to use it so not just in therapy.

6.2. Unable to Utilise Device Totally Independently

Some help was required in the movement and set-up of the S-Press, although this is not an uncommon feature of physiotherapy equipment such as motorised cycle devices, and even simple equipment like leg weights where patients usually require support setting them up. With the S-Press, it was identified that a barrier to independent use was the requirement to position it for use, which could not always be done independently; this meant that there could be opportunities missed when the machine could have been utilised more regularly and consistently.

S2: It's kind of getting others to sort of lift it and carry around, the patient can't do it, so they are relying on someone else to lift it, put it into position and take it out. That's one of the downsides. So, we can leave it in the room, it requires someone to lift it, put it on the bed or lift it, put it in front of the patient and position it. That, I would say probably one of the barriers to using it.

This also makes a potential barrier for its use at home. Whilst the general feeling of staff, patients, and relatives was that this would be a good device for home use that could enhance the patients' physiotherapy, it would be reliant on some patients having someone at home who could help them set up the S-Press. Without this, some patients would be unable to use the S-Press.

P7: *You have got to fix it onto your foot, and that's not easy to do. It's got to be attached properly. So, if I used it at home, there is that element that I would need somebody to help you fix it and get set up to use it.*

7. Impact and Benefits

This global theme collates the positive impact and benefits that the patients perceived they experienced through their engagement with and use of the S-Press. It is made up of four themes.

7.1. Believed that Legs Were Strengthened, and Muscles Built Up

All nine of the patients and both relative carers reported that their belief was that the S-Press was responsible for strengthening the legs and building muscles.

P2: *The strengths—it did help. As I say, it did ache the next morning, but that's part of how it comes. I felt stronger, and that I could weight bare a lot better. I think it was the feeling in my legs. Just felt stronger.*

P3: *I could see that and feel that it was a good benefit to the muscles in the backs of my leg. I did feel that.*

For some of the patients, there was also the belief that the S-Press was responsible for strengthening and building not only their affected/injured leg, but also what would be described as their 'good' leg, which was in danger of losing strength and muscle. It was felt that the S-Press could prevent this.

R1: *Well, it's certainly strengthened his leg, because he went not being able to do anything to being able to stand. And that was on both legs because it helped the good leg as it were and built up the bad leg.*

The professionals identified specific muscles they felt the machine strengthened.

S3: *Individualised muscle strengthening has been really good in terms of strengthening quads and helping make sure muscle length stays good. I think they had improved quadriceps and hamstring strength.*

7.2. Knock on Physical Achievements through Leg Strengthening

This is one of two sub-themes linked to the previous theme; this is about how patients experienced knock-on effects in the form of physical achievements that they associated as being related to their stronger legs gained through their use of the S-Press. Such knock-on physical achievements included walking:

P1: *It has made my legs, it made me legs stronger, and therefore I could walk better.... on the S-Press, it was making it easier to bend my knees, and sit down, and stand up and walk;*

stability and balance:

P2: *I felt it in my legs, felt more stable. Although, I still had my wobbly*

moments I did, in my good moment, far more stable. I think it helped with my balance;

standing:

P5: The S-Press really helped me. I actually used it with my, good leg, to help just keep that strength up so that I was standing;

and sit-to-stand:

S7: It helps a lot with their sit to stand. It makes sense that it would because they're doing resistive strengthening exercise for their lower limb, and that's going to help with their sit to stand and mobility.

Another knock-on outcome perceived was that strengthening the legs, improving walking, and transfers, positively impacted discharge for individuals, perhaps achieving this earlier, more safely and/or more easily.

P7: Well, it means I'm at home. And I believe the S-Press meant I got home quicker [because] it helped strengthen my legs, and so my walking.

S3: Improved strength which then improves control which means improved transfers which means safer discharges which means less complicated discharges. So, I could make that link.

7.3. Improved Confidence in Own Ability

The second sub-theme linked to the theme “*Believed that legs were strengthened, and muscles built up*” was around how participants experienced improved confidence in their ability, for example, in relation to standing, walking, and mobility.

P1: It gave me more confidence, I lost my confidence in walking with a Zimmer. And [using the S-Press] gave me a bit more confidence on walking and movement. I'm more confident in myself, that I could do it.

S5: I think if they're doing something positive for their physical health then it does give them confidence that they have got more strength, and then when they do come to stand and walk, they are standing and walking on stronger legs.

The S-Press seems to promote a virtuous circle for the patients, in that as their legs strengthened, this improved confidence, and so their ability on the S-Press improved, which meant patients felt stronger, and this gave them more confidence, and this cycle repeated itself.

S3: Their confidence improved when their legs strengthened and then the number of repetitions they can complete improved, which showed that they were stronger which gave them more confidence. So, it was a good knock-on effect.

7.4. Psychological Boost, Sense of Achievement

This final theme associated with the impact and benefits of the S-Press is how it, by using the S-Press, it brings psychological benefits. This psychological benefit is

associated with the feelings of improvement the patients believe they have experienced.

P7: And it helped psychological because improvement always helps psychologically. I could feel I was getting better, and, and I put it down to the S-Press and all the other things they were doing.

Using the S-Press and having it as part of rehabilitation gave individuals a feeling that they were doing something positive and helpful for themselves, resulting in a sense of achievement.

P4: The benefits for me actually, were not just physically it was mental as well, it made me feel as though I was actually positively doing something myself... but you actually feel as though you have achieved something, you know you have achieved it, not just physically, but emotionally, mentally as well.

The participants reported how, following the use of the S-Press, they had feelings of being productive and that they were proactively doing something themselves (not simply just being passive recipients). This was psychologically positive. As expressed by this relative, this psychological boost gave a sense of hope and feeling that there was a solution for their rehabilitation.

R1: It helped mentally and psychologically. Psychologically it gave him hope, and a practical solution of something he can work on regularly to build up.

8. Discussion

Based on a thematic analysis of interview data from patients, relative carers, and physiotherapists, an understanding has been gained as to how the S-Press is best integrated into practice, the useability of the S-Press for the patients and the staff, and the perceived benefits derived following its use. The results were made up of four global themes that captured this and comprised: 1) Experience of Users; 2) Facilitators; 3) Barriers; and 4) Impact and Benefits.

One of the key features of the S-Press was its useability and the integration of the device into patients' rehabilitation plans. It has been identified that muscle strength and function need to be assessed and preserved and should form a feature of patients' rehabilitation plans, particularly older and frail patients [34]. PRE is documented as being beneficial [21], yet it is not routinely used by physiotherapists in hospitals [9]. The S-Press offered an accessible, easy-to-use form of PRE that could be routinely used as an adjunctive treatment. The S-Press is beneficial compared to: in-bed exercises (patients lifting their own leg off the bed), which are difficult for many patients to perform this, and to do so effectively; resistance equipment such as ankle which can't be used by those with delicate skin, and are not particularly engaging; and resistance bands which require a good grip, strong arms, and an ability to hold the leg up straight, which many patients struggle with. In addition, in comparison to motorised bicycles, while these are helpful for passive movement, they do not target the leg muscles in the direct way the S-Press does,

they weigh 40+ kg, cost 3 - 5 times more than the S-Press, and are big, bulky, and difficult to store. Recent NICE guidelines [35] have suggested that needs-based rehabilitation for people after a stroke should be at least 3 hours a day, 5 days a week, covering a range of multidisciplinary therapy; the S-Press is something that can be routinely used and contribute towards achieving this. The S-Press was portable and easy to manoeuvre, could be adapted for use as per the patients' needs (e.g., in bed, sitting, choice of footplate), and could be used in place of other pieces of equipment that could not be accessed or would be difficult to set the patients up with (e.g., motorised cycle devices, gym). If a ward only has access to a bike, then the physio will need to transfer the patient from their bed into a wheelchair and usually take the patient to where the bike is kept. This takes up clinical time that is saved if the S-Press is used as it is positioned on the patient's bed with no requirement to move the patient. The S-Press provides an opportunity to implement PRE, where previously there might not have been the availability and opportunity to do so.

The S-Press offered an objective measure of progress, so that the physiotherapist and patient could see improvements based on levels of resistance and number of repetitions achieved. This augmented extrinsic feedback in physiotherapy [36] means that patients can get quantitative feedback on the parameters around resistance and the number of presses they can do, which aids engagement. In addition to this, the device was convenient to use and time efficient. Lack of time is a common barrier to evidence-based physiotherapy due to high workloads, competing priorities, and lack of resources [28] [37]. The S-Press was a resource that could address this by offering an intervention that saved time, gave the option of leaving patients to work with it independently (meaning physiotherapists could work with more than one patient at a time), could be incorporated as part of a group session, and was time-saving by being able to bring it to the patient as opposed to getting the patient off the ward and to the gym to be set up on equipment.

The S-Press was easy and straightforward to set up and use. This meant that it could be used efficiently and effectively with physiotherapists and beyond formal physiotherapy sessions as well. It could be used by other staff members without specific physiotherapy knowledge and training, as well as relatives and carers of the patients and, to some extent, the patients independently themselves. This means that the S-Press can be used often, consistently, and in the patient's home as required. The S-Press was found to be motivational for patient engagement with their physiotherapy. It has been suggested that a barrier to implementing PRE in hospitals is perceived poor patient motivation and the belief that some patients are unable to perform resistance exercises [20]; however, in the current study, it was seen that the patients were motivated to use the S-Press and were able to do the exercises on it. The S-Press provided exercise goals for them to work towards; goal setting has been considered integral to rehabilitation interventions [38], and goal setting is a key tenet of patient-centred musculoskeletal physiotherapy [39].

The S-Press gave patients an objective measure of progress and feedback, which was deemed to be motivational, and encouraged them to engage and carry on with their physiotherapy. It has been previously identified that patients prefer specific feedback when doing physiotherapy, as this is perceived as actual progress and has been found to increase motivation and self-efficacy, as well as give them hope [40]. The S-Press can offer specific feedback on progress, and if combined with physiotherapist input and feedback, is likely to encourage and motivate patients to continue with their PRE and rehabilitation, hopefully meaning they will achieve their desired outcomes in relation to their leg strength, mobility, and rehabilitation.

The use of the S-Press was associated with independence, ownership, and a sense of control for its users. This promoted empowerment and autonomy. Baste-meijer *et al.* [41] have identified that patients feel key values in their physiotherapy encounters, which include uniqueness and autonomy, as well as empowerment; understanding this can then help physiotherapists be patient-centred through the integration of these values into their practice. It is also the case that experiencing ownership of their rehabilitation has been found to make patients accountable, it positively affects the amount of activity they do and helps them cope with challenges [40]. Linked to this, ownership and empowerment were seen to advocate self-efficacy. Low self-efficacy has been identified as a barrier to treatment adherence and can result in low confidence in initiating and maintaining exercise or recovering from relapses [27]. Therefore, as part of the process of using the S-Press, it is important to ensure the patients have the confidence to use the device, that they can control how they use it, have feedback on how they are progressing, and so can build on this as part of their rehabilitation. This will then motivate patients to use the device and act as a facilitator, removing barriers to rehabilitation adherence and engagement.

Some missed opportunities to use the S-Press were observed, creating potential barriers to its use. Some patients require support in manoeuvring and setting up the S-Press, so they can only use it when this help is available. However, motorised cycle devices are far heavier (41 kg compared to the S-Press 7 kg) and should not be moved by patients under any circumstances. For these alternative devices, the patient generally needs to be transferred into a wheelchair and taken to the bike (if it is situated in a gym space), or it is moved by the physiotherapist to the patient's room. In addition, it needs to be near a plug and manoeuvred into position; all of this restricts the opportunity for use by the patients and physiotherapists. On that basis, the S-Press has many advantages over these alternatives, it is more portable and generally more easily manoeuvrable and straightforward to get to the patient. With the S-Press, though, because some patients cannot use it completely independently, it suggests that there could be opportunities missed for carrying out more regular and consistent PRE. This potentially means that it may prevent its use at home; however, relatives could help with this, and it could be used by community physiotherapists or visiting nursing staff. It is a more viable option compared to motorised cycle devices, which, whilst they can be purchased by patients

are expensive and are large and bulky; they are not portable devices that physiotherapists can bring into the community for use by patients during home visits. It was also found that in some instances, non-physiotherapy staff were reluctant to assist with the use of the S-Press at times when physiotherapists were not available, for example, over the weekend and out of hours. However, across all the narratives, it was identified that the S-Press was easy and straightforward to use, and it was found that there were instances of non-physiotherapy staff and relatives successfully helping with the use of the S-Press. Staff would just require adequate training, information, and knowledge about the S-Press and how to use it, so that they had the confidence and ability to support patients' use.

The S-Press is a valuable contribution to the strengthening of patients' legs and muscles and, as a result, helped improve stability, balance, standing, walking, and sit-to-stand. It must be noted, however, that the S-Press was used as one element of physiotherapy input and part of a rehabilitation plan, and the findings are based on the *perceptions* of patients, relative carers, and physiotherapists. However, these perceptions are aligned with previous randomised controlled trials (RCT) where it was identified that PRE results in modest improvements in gait speed, large effects on sit-to-stand, large effects on muscle strength, and small effects on physical ability [21]. S-Press offers a structured form of PRE that can be applied during early hospitalisation, which could contribute to preventing muscle deterioration and building strength, thus reducing the length of hospitalisation and facilitating quicker and easier discharge. By using the S-Press, a patient can perform beneficial progressive resistance strengthening exercises by starting on a level that they can manage and working, over several days and weeks, to progress to a higher level of resistance. Further research, such as an RCT, with specific outcome measures in relation to leg and muscle strength could isolate the contribution of the S-Press in this process.

9. Conclusion

The S-Press is a positive addition to patients' rehabilitation by offering PRE that is simple and easy to use, acceptable to both patients and professionals, and can be integrated as part of patients' rehabilitation plans. It offers a gym-equivalent progressive resistance that is size-appropriate to put on a patient's bed and for use in a chair. Bed exercises can be unengaging and ankle weights are unsuitable for patients with oedema, dressings, delicate skin, etc. The S-Press addresses these issues. The S-Press is a user-friendly device that is time-efficient for physiotherapists and effective in strengthening patients' legs and muscles and preventing hospital-associated deconditioning.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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