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ORIGINAL PAPER

COMPLEXITY AND INTENTION TO USE AN INNOVATIVE DEVICE FOR POST-INFARCTION PATIENTS: REHABILITATION NURSES' PERSPECTIVES

Rafael Alves Bernardes[1] iD **, Pedro Parreira**[1] iD **, Luís Sousa**[2] iD **, Arménio Cruz**[1] iD

¹The Health Sciences Research Unit: Nursing (UICISA:E), Nursing School of Coimbra (ESEnfC), Portugal
²Comprehensive Health Research Centre (CHRC), Department of Nursing, University of Évora, Portugal

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Abstract

Aim: This study aims to describe rehabilitation nurses' perspectives on the complexity of and intention to use an innovative device for post-infarction patients. *Design:* The research employed a qualitative method, with a video demonstration, and analysis provided by the participants. To guide the study, the Technology Acceptance Model was used in order to measure perceived usefulness and perceived ease of use. *Methods:* Focus Groups were used to collect nurses' perspectives on the developed device. Recruitment followed a snowball sampling method. Eligible participants received an email with an informed consent form. Privacy and confidentiality were maintained throughout. Content analysis was performed using ATLAS.ti v7, with Bardin's technique, i.e., an a posteriori categorical organization. *Results:* Three categories were identified as relevant to the study objectives: "Therapeutic adherence and motivation"; "Home and autonomy of the patient and caregiver"; and "Factors that facilitate the practice of the rehabilitation nurse". Participants felt that the innovation and technological complexity of the device might help to increase patient motivation and adherence, which would be of great use to rehabilitation nurses, allowing better intervention development. *Conclusion:* Participants perceived the device as useful to practice, and beneficial to post-infarction patients. Interestingly, the complexity inherent to the device is regarded as a factor that may increase motivation and adherence.

Keywords: cardiac rehabilitation, myocardial infarction, nurses, rehabilitation nursing, self-help devices.

Introduction

In order to make healthcare interventions more effective, and to counter the effects of immobility and / or lack of activity, innovations in healthcare have rapidly emerged, demonstrating potential for improving the quality of care, and making nurses more capable and proficient in the use of new technologies (Brysiewicz et al., 2015). In rehabilitative care, there has been an increase in the development of assistive devices that aim to contribute to the improvement of functional capacity, although many have significant limitations and high levels of inefficiency (Qian & Bi, 2014).

For cardiac patients, rehabilitation with these devices has generated very positive outcomes in terms of quality of life and performance of Activities of Daily Living (ADLs) (Kweon et al., 2017). In the first phase of cardiac rehabilitation (CR), there is a significant decrease in functional status and quality of life (Bodilsen et al., 2016). Rehabilitation

Corresponding author: Rafael A. Bernardes, The Health Sciences Research Unit: Nursing (UICISA:E), Nursing School of Coimbra (ESEnfC), Avenida Bissaya Barreto s/n, 3004-011 Coimbra, Portugal; email: rafaelalvesbernardes@esenfc.pt

nurses are a fundamental element in the mitigation of these problems (Castner et al., 2016); thus, the present study is intended to contribute by examining the utility of a medical device designed to assist in performing physical exercise in post-infarction patients in the first phase of CR.

Myocardial infarction is a clinical syndrome, characterized by an inflammatory response to myocardial cell death, usually triggered by pre-existing comorbidities such as chronic obstructive pulmonary disease or anemia (Jenča et al., 2021). According to the American Heart Association (Virani et al., 2021), the prevalence of cardiovascular diseases (CVD) in adults over 20 years of age is about 49.2%.

Post-infarction patients often present with dyspnea, fatigue, and pain, impacting their ability to accomplish most ADLs and constituting a complex health-disease transition for the person and family (Garcia et al., 2013; Silva, 2012). The first stage of cardiac rehabilitation involves bed rest and initial hemodynamic stabilization. In this context, rehabilitation nurses (RNs) have the responsibility of risk assessment, planning, designing, and developing safe, effective, and efficient rehabilitation

programs and interventions, and also through use of innovative technologies to assist functional recovery.

As an initial assessment, the RN should mainly focus on the patient's tolerance to activity and on information regarding degree of patient mobility before the disease (Potter & Perry, 2018). Thus, in the context of hospitalization, the assessment of mobility must encompass patients' coordination and balance – static and dynamic – especially when the patient is capable of walking again.

Furthermore, in the acute phase of acute myocardial infarction (AMI), in addition to the somatic symptoms already mentioned, the person and family find themselves in a period of fear, anguish, and distress (Garcia et al., 2013; Silva, 2012), which are feelings mainly related to uncertainty about the future (Lopes, 2011). Thus, it is important that RNs be facilitators of the health-disease transition, establishing realistic goals and helping patients to adapt to their new health status, especially by promoting empowerment in healthcare, making the patient the protagonist of the process, increasing his / her individual abilities, and mitigating the state of increased vulnerability in which he / she finds him / herself.

This study is part of a broader investigation into the dimensions and utility of *Ablefit* – designed for bedridden patients, it is an innovative device composed of a number of components mounted together, and attached to the bed. Currently, two prototypes have been developed: *alpha*, which has an ergometer for lower limbs; and *beta*, without an ergometer, but with progressive resistance bands and with real-time biofeedback provided via an attached computer.

Aim

The purpose of this study is to describe rehabilitation nurses' perspectives on the complexity of and intention to use an innovative device designed specifically for post-infarction patients.

Methods

The research used the Standards for Reporting Qualitative Research (O'Brien et al., 2014) to structure its content.

Design

A qualitative user-centered design method was chosen, involving focus groups. Before contacting the participants, the research team recorded two videos demonstrating the operation of each of the *Ablefit* prototypes. The device was first developed by nursing and mechanical engineering bachelor students, after which the project was further developed by research teams in The Health Sciences Research Unit: Nursing and the Coimbra Institute of Engineering, both located in Portugal. A national patent has been registered, and further development of main features is ongoing. The *alpha* prototype is a multi-component device, attached to the foot of the bed (incorporating a cyclo-ergometer for exercising the lower limbs), and to the head of the bed (with the option of a single resistance band for exercising the upper limbs). It can be folded for easy storage or transport. The *beta* prototype has a more rigid structure, which can also be attached to the feet or head of the bed. This prototype does not feature a cyclo-ergometer, but includes elastic bands of various resistances, identified by different colors. They can be used both to exercise the upper and lower limbs. It also has a load cell that measures the intensity, time, and force exerted by the person, sending the recorded data to a computer connected to the device.

The two videos were subsequently edited with voice-overs to facilitate understanding and combined into a single video with a duration of about six minutes. To guide the research, the Technology Acceptance Model (Lai, 2017) was used, to measure perceived usefulness (PU) and perceived ease of use (PEU), which directly influence intention to use new systems (Rahimi et al., 2018; Strudwick, 2015).

Sample

Rehabilitation nurses were recruited using an exponential snowball sampling method, in which each participant already included in the study is encouraged to invite two more participants. The following inclusion criteria were employed: nurses with minimum qualifications of postgraduate specialization in rehabilitation nursing; and clinical experience of at least three years as nurses (not necessarily as rehabilitation nurses). The exclusion criteria were as follows: general care nurses; and previous contact with the device under study (theoretical, i.e., through knowledge of the underlying concept; or practical, i.e., through previous experimentation). Invitations were sent by email, with an informed consent form attached. Recruitment took place between May and June 2020. Those who returned a signed consent form were then asked to indicate their availability for one of three focus groups, to take place in July 2020. Inclusion in a particular focus group was based solely on which of the three days proposed the participants were able to attend.

Prior to signing the informed consent, the individuals considered eligible to participate in the study received all relevant information regarding the objective of the study, the procedures inherent to the investigation, and the voluntary nature of participation. Privacy and confidentiality were ensured by the use of identification codes for each of the participants.

Data collection

The sessions took place via Zoom and were recorded with the authorization of those involved. After a brief presentation, the video mentioned above was shown and a Google Forms link was then sent with a sociodemographic questionnaire. The moderators guided the discussion with open questions, encouraging participation and limiting "deviation" from the topic in accordance with the guide prepared by the research team. Each session lasted an average of one hour.

Data analysis

Statistical analysis was performed with SPSS v25, and content analysis was performed with ATLAS.ti v7 software. Bardin's (2016) framework was followed for the different phases: 1) pre-analysis; 2) exploration of the material; and 3) treatment of results, and inference and interpretation. Categorical organization of the content was performed *a posteriori*, according to the "floating reading" method and rule of exhaustiveness, described by Bardin (2016). The codification, in turn, followed the following steps: 1) clipping – choice of units; 2) enumeration – choice of counting rules; 3) classification and aggregation: choice of categories.

Results

Three focus groups were organized: the first with five nurses, the second with six nurses, and the third with five nurses [a total sample of 16 participants (Table 1)]. Of these, 68.8% (11) were male and 31.3% (5) female, with an average age of 31.38 years (SD = 7.63). Twelve nurses (75%) worked in public hospital institutions and the remaining four nurses (25%) worked in Nursing Schools.

The content analysis identified 12 categories, which were arranged in three main domains: D1 – Functionality and learning; D2 – Intentionality and learning; D3 – Complexity and learning. This paper concerns the participants' perspectives on D2 and D3, which are the categories analyzed in the following section. The transcripts of the Focus Groups are followed by the participant ID code.

Therapeutic adherence and motivation

With regard to the contribution of the device to the person's adherence to the therapeutic plan, some participants noted the fact that its use is intuitive, making the process easier: *"The use seems almost automatic. I think it's intuitive, whatever the movement (...) I think it's easy to get adherence on the part of the patient"* (E1.6).

Since the device is different to what people are used to, i.e., it is innovative in clinical practice, it increases patient adherence and motivation:

"(...) All people like to exercise with something new, or innovative, I think it is good for adherence (...). Anything we give to the patient, other than an NaCl bag, which is what we often have to do, I think (...), [is a winner regarding] adherence, motivation (...)" (E1.6); *"Exactly, I agree"* (E1.2); *"And getting them to do exercises without being attached to something – they won't do it. But, if you put a pedalboard on, they do it, because they are attached to something – they start to see a goal"* (E3.3). Motivation is also boosted when there is positive feedback for the patient him / herself, encouraging him / her to continue. This can be achieved, for example, giving positive feedback: *"Congratulations! You managed to [pedal] for x time"* (E3.1).

The innovation factor was also regarded as a competitive advantage over devices currently used in institutions, particularly for the youngest: *"But more and more infarctions are occurring in young people. All these novelties, these technologies (...) would not be handicaps"* (E1.5). However, the same participant stresses that, for older people, the use of the device would have to be customized appropriately: *"Now, for older people, we required language adapted by us so that the anxiety would not increase (...) [There's] nothing like personalized information (...) [for gaining] acceptance from the patient him / herself"* (E1.5).

Treatment personalization, which includes health education, will influence not only the way in which the person regards its progression, but also the degree of adherence to the treatment that is proposed to him / her: *"The patient has to be aware of and have adherence to the therapeutic regime to know how to do it. You have to be aware of the values, the risk margins, where you can go, from what values you are at risk, to feel safe (...) Without knowledge, it is more difficult to collaborate and get involved"* (E1.5); *"(...) create some incentive that allows the patient to understand what stage he / she is at (...) something that could be meaningful to the person doing the exercise so that he / she*

Table 1 Sample characterization (n = 16)

Items		n (%)	mean	SD
Age (years)			31.38	7.63
Sex	male	11 (68.8)		
	female	5 (31.3)		
Academic training	post-graduation	4 (25.0)		
	master	5 (31.3)		
	doctorate	3 (18.8)		
	post-doctorate	1 (6.3)		
	missings	3 (18.8)		
Place of work	public hospital institution	12 (75.0)		
	higher education (nursing schools)	4 (25.0)		
Specialty of work	intensive medicine	2 (12.5)		
	nursing school	4 (25.0)		
	gastroenterology	1 (6.3)		
	pediatrics	1 (6.3)		
	medical oncology	2 (12.5)		
	internal medicine	4 (25.0)		
	physical medicine and rehabilitation	1 (6.3)		
	cardio-thoracic surgery	1 (6.3)		
Time of service in the place of work	$\leq$ 5 years	4 (25.0)		
	6–10 years	2 (12.5)		
	11–20 years	6 (37.5)		
	$\geq$ 20 years	4 (25.0)		
Time working as a nurse	6–10 years	1 (6.3)		
	11–20 years	6 (37.5)		
	$\geq$ 20 years	9 (56.3)		
Time working as a rehabilitation nurse	$\leq$ 5 years	5 (31.3)		
	6–10 years	3 (18.8)		
	11–20 years	6 (37.5)		
	$\geq$ 20 years	2 (12.5)		

SD – standard deviation

understood if he / she was effectively fulfilling the goal or not" (E2.1); *"It makes sense for them to be aware of the gains they are making every day"* (E3.5). This personalization also includes the individualization of interventions – taking into account the person's characteristics: *"(…) for it to function as a motivating factor, it has to be according to age and according to gender".* In fact, rehabilitation nurses should always take individual potential into account before proposing any intervention: *"Explain and understand whether the patient actually has the potential or not to use it. It would undoubtedly be important to take this into account"* (E1.5).

The introduction of technology into clinical practice is not an unequivocal decision, since there are always some drawbacks: *"And really, advanced technology can have advantages and disadvantages"* (E1.5). However, one of the particularly important advantages is, as a result of health education, the possibility of reducing the patient's dependence on the nurse, allowing him / her to gain autonomy and perform their own self-care, even in terms of rehabilitation: *"Taking the person to work always*

in the presence of the nurse may not be the most beneficial for the individual. Ideally, he / she should incorporate these activities and make a transition to his / her daily life from some of the exercises (…)" (E2.2). This autonomy is also acquired as the person, with the help of the EEER, sets personal goals and successfully realizes them or, conversely, does not manage to achieve them: *"The stimulus can be a graph or an image in which it can be seen that he / she is within the intended objective in speed or strength. As the speed decreases, he / she goes away from the objective"* (E3.2).

Home and autonomy of the patient and caregiver

The device's versatility, mentioned above, also allows it to be used at home: *"(…) I also regarded this device with great potential to be used in people's homes"* (E1.3); *"I think (…) the possibility of transferring it to the home is important"* (E1.6); *"Yes, it gives the patient autonomy. I think that would be excellent"* (E1.5); *"This device as a homecare is quite versatile"* (E2.2).

Factors that facilitate the practice of rehabilitation nurses

With regard to the practice of rehabilitation nurses, the participants highlighted several factors of the second prototype that would be facilitators: *"From the point of view of the professional, the second always brings more advantages"* (E1.6).

Biofeedback allows the professional to guide his / her exercises: *"(...) the teams can soon give some direction to the person. To say that there is a greater increase than this and that – therefore, you have to decrease or stop the exercises"* (E1.3); *"(...) the added value (...) would be biofeedback, which the vast majority of devices that we use do not have"* (E2.5).

An interesting aspect highlighted was the device as an adjunct to the professional's practice, empowering the patient, but without impacting the nurse: *"We could have a device or a machine that enhances the patient's ability, without effecting the ergonomics of the rehabilitation nurse (...) the objective is to enhance the patient's autonomy (...) without compromising our physical health"* (E2.4).

When using this device, the nurse is also more available for other tasks: *"This equipment allows the patient to have some autonomy, making the nurse available to develop other activities. With all these emergencies and this schedule, it would be an amazing thing"* (E3.4).

Discussion

This study aimed to describe rehabilitation nurses' perspectives on the complexity of and intention to use an innovative device specifically for post-infarction patients. Prototypes of *Ablefit* were assessed regarding their usability and several issues were identified by participants, including customization and adequate development of innovations for older people. In fact, the complexity of a device exerts a significant influence on older adults' motivation. A device which can mimic prehospital ADLs is particularly relevant, since these daily activities are a predictor for complications and negative outcomes in people with AMI (Nakajima et al., 2016). Nevertheless, adherence to new devices is not a simple process and requires further exploration among professionals.

Deng et al. (2018) stress that trust, perceived utility (PU), and perceived ease of use (PEOU) are strong predictors for greater adherence to *mHealth* services. Even so, although trust is the factor that has the greatest influence in this process, followed by PU, and PEOU (Deng et al., 2018; Huang et al.,

2012), participants focused more on the ease of learning and simplicity of the device. The development of *Ablefit* seems to be a positive contribution to the discussion started by Seewoodharry et al. (2017), in which they conclude that feedback guided either by objective or subjective measures improves adherence to treatment. More interestingly, the authors state that such feedback might be important in preventing adherence from weakening throughout treatment, which is in accordance with the suggestions and comments of nurses about the broader coverage of areas of *Ablefit*, particularly homecare.

According to the theoretical model developed by He et al. (2018), perceived ease improves the belief of the end-users in their ability to perform the indicated task. Therefore, the development of simple and intuitive devices is urgent from the user's point of view. In fact, regarding the category "Home and autonomy of the patient and caregiver", the autonomy which is sought by nurses when considering transference of the device to the person's homes, addresses a core theme of Nursing: i.e., helping people to adapt to their new situation and promoting re-integration in the community. Meleis's transition theory has been much applied in this context (Halpin & Hodge, 2019; Paiva & Ferreira, 2018), namely in AMI (Koh et al., 2016). In this sense, homecare emerges as a new trend in healthcare, wherein complexity of medical devices must be alleviated and intention to use promoted according to very different user profiles (Bitterman, 2011).

The suggestions provided by the participants with regard to the introduction of virtual reality with direct feedback to the person and caregiver, telemedicine, and the installation of the device at home contribute to another trend that is currently occurring in the area of CR, whereby psychological follow-up is essential in preventing anxiety. Positive feedback messages generated during exercise, either through text or images, as suggested by the participants, might increase the person's motivation and psychological well-being, as their own established and realistic goals are met. A recent risk model developed by Hajduk et al. (2020) identified seven risk factors for functional decline in older adults after AMI, one being depression, which can be changed when patients are more willing to engage in specific strategies during their treatment (Burns et al., 2013).

We have recently witnessed the development of so-called Social Assistive Robots (Casas et al., 2019; Okamura et al., 2010) for pathologies such as stroke, and for areas such as mental health, geriatrics, and

cardiac rehabilitation; thus, the proposed suggestions follow international developments. Participants recommended that the patient be able to visualize variations of parameters in real time while exercising, as well as safety limits. It was also recommended that a system of emoticons (or *"emojis" / "smilies"*) be included to provide simple biofeedback. In this context, Casas et al. (2019) suggest that the user-device interface should consist of three dimensions previously mentioned as important: 1) motivation; 2) warnings; and 3) emergency. The panel suggested by the participants should also include features managed by the patient him / herself, such as the Borg Scale score indication, and also Start and Stop buttons, as illustrated in the system developed by Casas et al. (2019).

The same authors mention that people's expectations about the usefulness and safety of the devices were, in general, not high; however, it is possible to overcome this after a reasonable period of interaction between the user and the device. In fact, the early implementation of new technologies, such as *Ablefit,* which are highly suitable for use at home facilitates motivation and recovery. Therefore, it is opportune to suggest that a screen be included on the device itself that is intuitive and easy for the patient to use. Another example of the same type of functionality is that constructed by Lara et al. (2017), which is similar to the interface developed by Casas et al. (2019).

There was concern among the participants regarding the autonomy of the patient and caregiver, particularly the importance of being able to use *Ablefit* in the home environment. However, some mobile applications are already available on the market which can enrich the device under development. One example is that of Lee et al. (2017), which helps in the managements of the patient's exercise regime and his / her contact with a healthcare professional.

There is, therefore, an importance in adopting applications and digital platforms that allow the professional to keep in contact with the patient, while he / she complies with the prescribed plan, which also improves the performance of CR at home (Thomas et al., 2019). The development of medical devices for the rehabilitation of bedridden patients, including programs for CR, will naturally follow future trends in this field: virtual reality, gaming, mHealth, and telemedicine / telenursing.

As stated by Myskja & Steinsbekk (2020), tomorrow's personalized medicine implies a significant effort to promote patient autonomy through empowerment interventions.

Limitation of study

Certain limitations pertain to the study, including the involvement of few nurses from cardiac specialties, and the absence of interviews or focus groups with post-AMI patients, which would have enriched the results. Also, due to the SaRS-CoV-2 pandemic, nurses were unable to use the device in a simulation scenario, which, in turn, did not allow for broader exploration and discussion of its components.

Conclusion

The study revealed three significant categories to be explored regarding complexity and intention to use *Ablefit*: "Therapeutic adherence and motivation"; "Home and autonomy of the patient and caregiver"; and "Factors that facilitate the practice of the rehabilitation nurse". The participating nurses considered the device's innovative design to be attractive, which, in turn, increased patient motivation during cardiac rehabilitation. Although some complexity exists due to the technological development of *Ablefit,* the *biofeedback* systems developed on the *beta* prototype seem to be important in helping patients set and achieve their own goals, even after they returned home. Intention to use is positively affected when personalization exists, a potential for which is present in both prototypes, particularly in the *beta* version. Both prototypes are an important assistive device, not only for patients, but also for rehabilitation nurses, which help to develop and plan specific interventions and adapt them to the patient's efforts and capabilities.

Author contributions

Conception and design (RAB, PP, AC), data analysis and interpretation (RAB, PP, AC, LS), manuscript draft (RB), critical revision of the manuscript (RAB, PP, AC, LS), final approval of the manuscript (PP, AC, LS).

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