INPLASY PROTOCOL

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None declared.

Facilitators, barriers, and design requirements for the implementation of rehabilitation robots in patients with mobility disabilities: protocol for a scoping review

Bi, XY[1]; Yan, Y[2]; Yun, B[3]; Ye, XC[4].

Review question / Objective: **This scoping review aims to explore factors that influence the implementation of rehabilitation robots for patients with mobility disabilities in real-world practice. The detailed objectives should be addressed as follows: (1) the contributing factors of using rehabilitation robots in patients with mobility disabilities; (2) the design requirements for rehabilitation robots in patients with mobility disabilities.**
Eligibility criteria: **Titles and abstracts will be screened to remove the irrelevant references according to the following inclusion criteria: (1) use of rehabilitation robots or exoskeletons as an intervention; (2) involve patients with mobility disabilities, not caregivers, therapists, nurses, etc.; (3) articles in the English language due to the time and cost of translating papers in other languages; (4) primary empirical studies, such as qualitative, quantitative or mixed-methods study design; (5) include information about barriers, facilitators, and design requirement that affected implementation. Then, the following exclusion criteria will be considered: (1) non-empirical studies such as review, editorial, protocol, or comment; (2) articles just exploring the clinical effectiveness of robotic devices in patients' motor rehabilitation; (3) abstracts published in congress and conferences.**

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 17 August 2022 and was last updated on 17 August 2022 (registration number INPLASY202280069).

INTRODUCTION

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addressed as follows: (1) the contributing factors of using rehabilitation robots in patients with mobility disabilities; (2) the design requirements for rehabilitation robots in patients with mobility disabilities.

Background: According to estimates by the World Health Organization, more than 1 billion people in the world suffer from some type of disability and the number of persons with disabilities is growing dramatically, becoming an increasingly large component of disease burden and health expenditure. Physical disability takes up about 30% of the disability and often occurs after accidents, injuries or illness, which can also limit their activities and mobility. Mobility limitations or difficulties have been found to effectively predict various adverse outcomes, such as decreased health-related quality of life, increased physical frailty and fall risks, poor mental health, and restricted social participation. Mobility rehabilitation has been demonstrated to be greatly beneficial in rebuilding or improving the mobility and function of patients with physical disabilities, for example, in studies with stroke and spinal cord injury (SCI) patients. Recently, rapid advances in technology have created an excellent opportunity for technology-support mobility training, allowing therapists to be free from repetitive and intensive traditional physiotherapy while maintaining recovery effects. Especially, rehabilitation robots have been effectively applied for mobility training in various conditions, such as stroke, SCI, and multiple sclerosis. A meta-analysis of 38 included studies by Veerbeek et al demonstrated the effectiveness of rehabilitation robots for upper limb functions in post-stroke patients, including improved motor control, increased muscle strength, and enhanced activities of daily living. On the other hand, a meta-analysis by Nam et al included 10 trials and found positive effects of robot-assisted gait training on improvement in walking functions in patients with SCI, including gait distance, walking speed, leg strength, functional level of mobility, balance, spasticity, and independence. However, negative findings have also been reported in some studies, not all positive ones. Two randomized controlled trials compared the clinical effectiveness of robot-assisted training and usual care or intensive therapy in patients with upper limb disability after stroke and found that robot-assisted therapy could not improve their motor function. Many reasons for the ineffectiveness of robots in functional improvement were noted, such as insufficient instruction to participants and recruitment of patients with little prospect of recovery. Since the clinical effectiveness of robots in motor rehabilitation has been assessed, the further step should be to examine their application in real-world practice, where implementation settings differ from study contexts for clinical trials. Generally, clinical trials have specific time courses that tend to be temporary in nature and interventions will be discontinued once clinical trials end, while contributing factors to the implementation of robotic devices in real-world contexts may not be reflected in clinical trials. Although several reviews have identified facilitators and barriers to the implementation of social robots and telepresence robots in specific patient populations, reviews targeting factors that influence the use of robotics in motor rehabilitation are still lacking. Nevertheless, some interesting results have also been found in recent reviews on rehabilitation robots. For example, a qualitative meta-synthesis of 30 studies was conducted by Laparidou and colleagues to identify end-users' (patients, caregivers, and healthcare professionals) perceptions of and experiences with robotics in motor rehabilitation. The findings of this review showed that despite the experienced challenges in technology and logistic, participants found robotics in motor rehabilitation to be acceptable and interesting, as well as beneficial for physical, psychological, and social functioning. In addition, a scoping review of nine studies by Li et al identified and synthesized 42 design requirements for upper limb rehabilitation robots regarding functionality, usability, software, and safety.

Rationale: The Components model of User Experience Model (CUE model) will be used

in our review to facilitate our data gathering, analysis, and interpretation of the facilitator, barriers, and design requirements for the implementation of rehabilitation robots in patients with mobility disabilities. The CUE model was developed by Mahlke and Thüring to accurately predict the users' appraisal of the product through distinct components of user experience in the human-technology interaction. Perception of instrumental and non-instrumental product qualities is distinguished in this theoretical model. Instrumental product qualities include the usefulness and usability of the product (e.g., controllability, effectiveness, learnability), whereas non-instrumental product qualities comprise its attractive features, such as visual aesthetics, haptic quality, and identification. The perception of both qualities is directly influenced by interaction characteristics, which contain user characteristics, product features, and task/context. In addition, emotional reactions are also identified as a crucial part of user experience and are defined as episodes of subjective feelings accompanied by behavioral expressions and physiological reactions. Such emotional episodes might appear in a repetitive manner during interactions with the product and consequently build the client's overall emotional reactions to it. In the CUE model, emotional reactions are influenced by perceptions of both types of qualities, and all three components together directly determine appraisal of the product, such as overall judgment, usage behavior, and choice of alternatives.

METHODS

Strategy of data synthesis: An initial literature search will be conducted in two electronic databases: MEDLINE and Web of Science and search terms will include rehabilitation, robots, implementation, patient, and disability. In this process, the text words and index terms from titles and abstracts of searched articles will be analyzed and sorted out to identify the terms for the following systematic search. Then, the following electronic databases will be searched for relevant published papers or literature, including MEDLINE, Web of Science, PubMed, ProQuest, Scopus, and Embase. In addition, to ensure that all relevant studies will be identified, grey literature sources (e.g., Google Scholar) and the reference lists of included studies and relevant reviews will also be searched in our review. No search restrictions on the year of publication will be applied and all databases will be searched from inception. Furthermore, the taxonomy of implementation outcomes proposed by Proctor et al will be applied as the guidance of the literature search for papers related to implementation, including acceptability, adoption, appropriateness, feasibility, fidelity, cost, penetration, and sustainability. These constructs in the taxonomy have been used in a scoping review conducted by Koh et al to overview the barriers and facilitators to the implementation of social robots for older adults and people with dementia, and have been proven effective to guide the construction of search strategy, ensuring the completeness and thoroughness of the literature searches. Additionally, terms (e.g., view, experience, perception, intention, and perspective) will also be included in our search strategy to identify more relevant articles. This scoping review will not include terms such as factors, determinants, facilitators, barriers, and design requirements in the search strategy since these terms may not be noted in the titles or/and abstracts. Similarly, disease-related terms such as disability, stroke, and spinal cord injury will not also be contained in our search strategy to ensure that any potentially relevant papers are not neglected. Therefore, the relevant information will be evaluated in the final two stages by reading the full-text articles, which will allow us to thoroughly overview the facilitators, barriers, and design requirements for implementing rehabilitation robots in patients with mobility disabilities caused by various diseases or accidents.

Eligibility criteria: Titles and abstracts will be screened to remove the irrelevant references according to the following inclusion criteria: (1) use of rehabilitation

robots or exoskeletons as an intervention; (2) involve patients with mobility disabilities, not caregivers, therapists, nurses, etc.; (3) articles in the English language due to the time and cost of translating papers in other languages; (4) primary empirical studies, such as qualitative, quantitative or mixed-methods study design; (5) include information about barriers, facilitators, and design requirement that affected implementation. Then, the following exclusion criteria will be considered: (1) non-empirical studies such as review, editorial, protocol, or comment; (2) articles just exploring the clinical effectiveness of robotic devices in patients' motor rehabilitation; (3) abstracts published in congress and conferences.

Source of evidence screening and selection: All articles that focused on the facilitators, barriers, and design requirements for the use of rehabilitation robots will be included in this scoping review. Three stages of study selection will be performed independently by two reviewers to determine eligibility. In the first phase, all references from the databases will be imported into EndNote software and duplicates will be removed. In the second round, titles and abstracts will be screened to remove the irrelevant references according to the above inclusion and exclusion criteria. In the final phase, full-text articles of included studies will be screened. The two reviewers will compare their decisions at the end of each process. Any ambiguity or disagreements will be addressed through discussion among all the authors during each process of study selection.

Data management: The important elements of the selected papers will be extracted and recorded in a standardized and pre-piloted form using Microsoft Excel. The information extracted from the eligible studies will be listed as follows: (1) study characteristics (eg., author, year of publication, country, study design, methodology, study setting, and participants' demographics); (2) intervention and their outcomes of the use of rehabilitation robot; (3) facilitators and barriers to the implementation of rehabilitation robots in patients with mobility disabilities; and (4) design requirements for rehabilitation robots with respect to user and technology needs. Two reviewers will independently conduct a pre-test on a random sample (10%) of the selected papers to ensure the consistency of the data drawn in the form. The form will be modified and supplemented by an iterative process if necessary. Then, the relevant information will be extracted by one reviewer and revised by another reviewer. Any differences in evaluation between the two reviewers will be discussed until consensus is reached and with the corresponding author if necessary.

Reporting results / Analysis of the evidence: The findings of the selected articles will be collated, summarized, and reported in this stage. Firstly, the frequency of the descriptive characteristics of the eligible studies (eg., author, year of publication, country, study setting) will be described. Then, the intervention and the outcomes of rehabilitation robots will be summarized and tabulated. Next, directed content analysis will be conducted to synthesize and organize the extracted information. The facilitators and barriers to implementing rehabilitation robots will be mapped and presented in a structured manner, as well as the clinical and technical design requirements. The findings of this scoping review will be gathered, analyzed, and interpreted using the CUE model. Any inconsistencies in the results of synthesis will be addressed and resolved through full discussion among all authors. The results of this scoping review will be reported in a narrative manner using the PRISMA-ScR checklist and gaps in the literature will be analyzed and discussed to identify directions for further research.

Language restriction: English.

Country(ies) involved: China.

Keywords: rehabilitation; robot; health informatics; information technology.

Dissemination plans: The findings of this scoping review will be shared through a publication in a peerreviewed journal and relevant conference presentations.

Contributions of each author:

Author 1 - Xuanyi Bi - BXY conceived the study, conceptualized the research questions and drafted this protocol.
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