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Pursuing quality education in physical and rehabilitation medicine

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Pursuing quality education in physical and rehabilitation medicine

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Editorial: Pursuing quality education in Physical and Rehabilitation Medicine

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Editorial on the Research Topic
Editorial: Pursuing quality education in Physical and Rehabilitation Medicine

Introduction

What is the value of education in Physical and Rehabilitation Medicine (PRM) and why bothering about it would strengthen rehabilitation in health systems and eventually improve health care? The collection of articles in the Special Issue about Pursuing quality education in Physical and Rehabilitation Medicine addresses these fundamentally important questions through different approaches:

- Launching a call for optimizing education in PRM as a tool for relieving the burden of disability in low-income countries (Cannata et al., Tannor et al.);
- Providing examples of the current and near-future approaches to PRM education, (Asami, Herrera-Ligero et al., Leochico et al.);
- Highlighting strategies to ensure the highest level of postgraduate training as a mean to support high-quality interventions of PRM physicians in disability and health care (Brown et al., Posada-Borrero et al., Scheel-Sailer et al.);
- Describing how the competency-based education for PRM trainees has changed during the COVID-19 pandemic (Leochico et al.); and
- Emphasizing the importance of teaching the basics of scientific research to postgraduate PRM trainees to prepare them to choose evidence-based treatments, promote scientific research in PRM and eventually improve management (Thibaut et al.).

Why bother about education in PRM?

PRM is defined as the "medicine of functioning". This is a key concept to understanding the value of this medical specialty, linking its scope to the intrinsic value of rehabilitation. Rehabilitation is a person-centred process including interventions designed to optimize functioning in individuals with health conditions or impairments in interaction with their environment (1); as such, it is an essential health strategy for increasing health and well-being, improving quality of life, delaying the need for long-term care and empowering

persons to achieve their full potential and participate in society (2). Lack of access to rehabilitation may expose persons with rehabilitation needs to higher risks of marginalisation, poverty, vulnerability, complications, and comorbidities, adversely impacting their function, participation, and inclusion in society (3).

On May 27th 2023, the 76th World Health Assembly (WHA) adopted a landmark resolution on "Strengthening Rehabilitation in Health Systems", taking a historic step towards acknowledging that rehabilitation is an essential element of universal health coverage, while admitting that worldwide rehabilitation needs are largely unmet, and more than 50% of people miss the rehabilitation services they require in many low and middle-income countries (LMIC).

This inadequacy is the outcome of several interacting factors:

a) Poor consideration of functioning as the third indicator of health, complementing morbidity and mortality, and, consequently, poor integration of its assessment in the health information system and poor attention to functioning by policymakers, when setting health priorities and allocating resources;
b) Limited exposure of medical students to training in the care of people with disabilities; this issue is of particular relevance when we consider the emphasis given by the World Health Organization (WHO) on the need to integrate rehabilitation services within all health system levels, including primary health care (4)
c) Lack of awareness among healthcare providers of the relevance of rehabilitation across the life course and for a wide range of health conditions;
d) Poor promotion of academic capacity in PRM worldwide;
e) Poor awareness that quality education and training of rehabilitation professionals (including PRM physicians) is an investment in the health of populations;
f) Insufficient workforce and equipment to respond to the increase in rehabilitation needs created by the progressive population aging combined with the impressive expansion of chronic disorders.

The Rehabilitation 2030 initiative introduced a "call for action", gathering stakeholders towards coordinated global actions to scale up rehabilitation (5). Among the 10 priority areas for action, the need for:

- Creating strong leadership and political support for rehabilitation at different levels,
- Developing a strong multidisciplinary rehabilitation workforce,
- Promoting rehabilitation concepts across all health workforce education, and
- Building research capacity to expand the availability of robust evidence for rehabilitation

calls for emphasising the pivotal role of PRM physicians and harmonising post-graduate education in PRM.

To accomplish their role of "medical specialists of functioning", the PRM physicians are called to plan the rehabilitation process, tailoring it to the individual health needs (6). With more than 2.4 billion individuals worldwide experiencing a vast range of physical and mental health conditions (permanent or temporary) —and potentially benefitting from rehabilitation (7), the PRM physicians are expected to develop an equally wide range of competencies and skillsets. Moreover, the strong collaborative association with other rehabilitation professionals calls for the development of good leadership, management and communication skills.

Education in PRM is also required at the undergraduate level, in medical schools. Virtually all physicians will encounter people with disabilities in their clinical practice across various pathologic conditions. However, studies demonstrate that people with disabilities are inadequately referred for rehabilitation even in developed countries. A systematic analysis of academic medical institution education offers in the United States reported that the undergraduate medical education system does not adequately train students to provide care for people with disabilities. The most common reason for not delivering a disability awareness curriculum was that no one advocated for its inclusion (8).

Advocacy is the mission of the World Rehabilitation Alliance (WRA), a WHO global network of stakeholders, committed to supporting the implementation of the Rehabilitation 2030 Initiative, by increasing the awareness and demand for rehabilitation, and, especially in LMIC, driving investment in quality rehabilitation education and training, and expanding the integration of the rehabilitation workforce into all levels of care and practice settings (9).

Pursuing quality education in PRM: where are we?

In the European Union, harmonising staff education at the undergraduate and postgraduate levels is a mandatory element for ensuring the highest standard of rehabilitation care across different countries (10).

To support the widespread adoption of standards in PRM education, and overcome the current discrepancies in the duration and contents of PRM training throughout Europe, the European Board for PRM has released the European training requirements (ETR) for PRM education, that detail the theoretical knowledge (learning outcomes) and the core competencies to be achieved at the end of training (training outcomes), in preparation for the independent practice of PRM (11).

At the world level, the Education Committee of the International Society of PRM (ISPRM) released the first version of the recommended Core Curriculum and Competency, in 2019 (12) with the goal of providing a set of fundamental practical knowledge requirements and competencies expected in the professional practice of PRM. The document considers the variability in practice and resource availability in each geographic location, so the emphasis is placed on basic concepts and principles of PRM, with the addition of some topics/conditions, to serve as a guide for training programs.

Developing competency-based education can represent a powerful mechanism to align education and training with health

system priorities. This holds particular value for resource-limited countries, where the knowledge and skills of rehabilitation doctors need to reflect not only the population's health profile but also the strengths and weaknesses (e.g., workforce gaps and maldistributions) of the health system.

In the African Region, where there is a substantial lack of PRM physician workforce, as PRM training programs are missing, the International Rehabilitation Forum (IRF) developed and implemented a fellowship program to train physicians in rehabilitation medicine, in Ghana, Ethiopia and Cameroon (all LMICs in sub-Saharan Africa). Tannor et al. commented the IRF initiative shedding light on the ongoing challenges of inadequate availability of PRM trainers, logistics and services for hands-on experience, and funding. They also reported how it becomes especially difficult to set up PRM training programs in countries where not only PRM trainers but also allied rehabilitation professionals are missing.

Conclusion

High-quality rehabilitation care represents a constitutive element of health systems worldwide. The harmonisation of staff education both at the undergraduate and postgraduate level is a key element for ensuring the highest standard of rehabilitation care. International bodies, like the UEMS Board for Physical and Rehabilitation Medicine (PRM) or the ISPRM, have already delivered regulatory documents setting standards in postgraduate PRM education. Implementing such rules is to be validated worldwide with special attention to low and middle-income countries.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Development of a Clinical Practice Guideline for Lower Limb Amputees. A Knowledge Translation Process in a Middle Income Country

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Background and Aim: Knowledge translation processes are necessary for improving patients' and communities' health outcomes. The aim of this study was to systematically develop evidence-based recommendations for people over 16 years of age who are in risk for or have suffered a lower limb amputation for medical reasons (vascular, diabetes mellitus) or trauma (civilian or military trauma) in order to improve function, quality of life, decrease complications and morbidity.

Methods: Following the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach we developed a Clinical Practice Guideline (CPG) for lower limb amputees with funding from the Ministry of Health in Colombia and participation of a multidisciplinary group. We included patients' preferences. Based on the scope, purposes and objectives the questions were elaborated with the PECOT strategy. The evidence search was performed for each question in the main databases: Cochrane Library, Embase and PubMed, without time limit or language restriction. Teams were formed with thematic experts and clinical epidemiologists to review the clinical studies, describe the evidence, and evaluate the quality of the body of evidence with the GRADE methodology. The recommendations were made according to the judgments proposed by the GRADE working group. We conducted a stakeholder's dialogue as a mechanism for the external validation of the guideline implementation.

Results: The CPG included 43 recommendations related to the diagnosis, surgical treatment, rehabilitation, prescription and adaptation of the prosthesis. They were strong in favor 37.2, weak in favor 53.5, strong against 2.3, Weak against 7.0%. Quality of evidence was high in 0, moderate in 11.6, low in 58.1, and very low 30.2%.

Discussion: In 93% of the recommendations, the quality of the evidence was between low and very low. This is why it was so important to validate and discuss each recommendation with an expanded multidisciplinary group. The research group identified 25 interventions and five milestones to be prioritized in the implementation and in the stakeholder's dialogue participants identified opportunities and barriers for implementation of recommendations.

Conclusion: It is necessary to develop a national policy for implementation strategies of CPG recommendations that promotes the necessary arrangements for the provision of services for diagnosis, treatment, and rehabilitation of individuals with amputations.

Keywords: implementation, clinical practical guidelines, lower limb amputation, knowledge translation (KT), rehabilitation

BACKGROUND

Evidence-based clinical practice guidelines (CPG) are a fundamental tool for reforming medical care and strengthening health systems to achieve better health outcomes for patients and their communities (1, 2). However, despite the rigorous systematic synthesis of the scientific evidence contained in high-quality CPG, not all of them can be easily and directly translated into practice (3, 4).

In 2008, the Colombian Ministry of Health and Social Protection (MoH), financed the development of the methodological guideline for the development of evidence-based CPG in Colombia, this guideline was updated in the year 2014 (5). Between 2008 and 2016, the MoH in Colombia financed and convened the elaboration of 58 national CPG that were elaborated with the best methodological standards, by professionals from recognized universities in Colombia, with the participation of scientific associations, healthcare professionals and patients and caregivers. The purpose was to reduce unjustified variability in medical practice, improve the efficient management of resources, and be able to offer patients the most effective and safest interventions (6). A CPG implementation manual was also developed, with general suggestions about how to implement these CPGs in the different healthcare provider institutions (7).

In 2013, through a call of the Administrative Department of Science, Technology and Innovation (nowadays Minciencias) and financed by the MoH, we developed the "Clinical Practice Guideline for diagnosis and preoperative, intraoperative and postoperative treatment of the amputee, the prescription of the prosthesis and comprehensive rehabilitation" (8). An interdisciplinary group involved in the care of amputee patients from different cities in Colombia participated in its preparation. This guideline was updated in 2018.

One of the most consistent findings of clinical and health services research is the challenge to translate research evidence into practice (1). This have been reported around the world in different income level countries and in different sectors of care, such as primary or specialty care (1).

The US National Center for Dissemination Research on Disability defines knowledge transfer as "The collaborative and systematic review, evaluation, identification, aggregation, and practical application of high-quality research on disability and rehabilitation by key stakeholders, in order to improve the lives of people with disabilities" (9). This definition recognizes that there is a wide range of stakeholders for knowledge transfer, including policy makers; health providers; end users, researchers and industry. It is important that these transfer processes are implemented, especially in low and middle-income countries, strengthening the rehabilitation of people with disabilities.

The aim of this study was to systematically develop evidence-based recommendations for people over 16 years of age who are in risk for or have suffered a lower limb amputation for medical reasons (vascular, diabetes mellitus) or trauma (civilian or military trauma) in order to improve function, quality of life, decrease complications and morbidity.

MATERIALS AND METHODS

Participants

The main guideline developer group consisted of 14 people, including physicians, physiatrists, orthopedists, vascular surgeons, experts in prosthetics, psychiatrists, physiotherapists, occupational therapists, clinical epidemiologists, public health doctors, economists, a documentary librarian, and undergraduate and postgraduate students. A group of professionals from different universities and scientific societies validated the different stages of the process. A focus group of 24 people with amputations of different causes and their relatives were linked to the process in two moments, when the questions were chosen and at the end of the recommendations. The developer group received a training process with different international centers as the McMaster University, the *National Institute for Health and Clinical Excellence* (NICE) and the *New Zealand Guidelines Group*. The users of the CPG are all the professionals who were involved in the development: surgeons, physiatrists, other professionals in the area of rehabilitation, insurers, health providers and political decision makers.

Ethical Aspects in the Development of the CPG

All the professionals who participated in the development made a declaration of interests at the beginning and each year. These are published as supplementary files within the CPG document (8).

The financing entity was the Ministry of Health and Social Protection, none of the people from this entity participated in the group developing the CPG. The Ministry carried out permanent monitoring to guarantee compliance with the methodology and schedules.

GPC Search and Quality Appraisal

CPG for lower limb amputees were searched for, and an evaluation of quality was made with the AGREE II Instrument. Six CPG were evaluated independently by two professionals from the group. Only three with a score greater than 60 in

the methodological domain were selected, which were used as information during development. (8).

Prioritization of Outcomes and Elaboration of Questions

The development of the CPG followed the GRADE (Grading of Recommendations Assessment, Development and Evaluation) methodology (10, 11). For the elaboration of the recommendations of the CPG, within the guideline development group (GDG), a process of prioritization of the topics of interest was carried out and the most important were selected. Subsequently, clinical questions were formulated and a systematic review of the available evidence was made on each one. This process was done between 2014 and 2015. The main recommendations were updated in 2018.

Based on the scope, purposes and objectives of the guideline, the questions were elaborated with the PECOT strategy (Population, Exposure or intervention, Comparison, Outcomes and Time). Then the developer group and the patients independently rated the importance of each outcome from 1 to 9, according to the GRADE classification (11). According to the average scores of the developer group, the outcomes were classified as: critical (7-9), important non-critical (4-6) or not important (1-3). The evaluation of the quality of the body of evidence is done by selecting the critical and important outcomes.

Literature Search Strategy

For each question, a list of MeSH terms was prepared according to the population, the intervention and the comparison. The evidence search was performed in the main databases: Cochrane Library, Embase and PubMed, and in secondary databases such as Lilacs/Bireme, Current Controlled Trials, TripDatabase and Google Scholar. There was no language restriction. For the selection of the evidence, inclusion criteria were established with respect to the methodological design, the population and the minimum quality characteristics. Systematic reviews and meta-analyses (secondary or aggregative studies), which analyzed primary studies related to the question, were initially sought. Additionally, clinical trials and observational studies were identified.

Appraisal of the Quality of Evidence

The quality of the evidence was evaluated for systematic reviews and meta-analyses with the AMSTAR (12); for diagnostic studies the QUADAS (13); and with the STROBE for observational studies (14). The quality of the body of evidence was assessed according to the concepts of the GRADE methodology (11), by qualifying each outcome. This process was done by orthopedic doctors, physiatrists, and clinical epidemiologists, who were experts in the GRADE methodology. GRADE publications can be accessed on the website https://www.gradeworkinggroup.org/.

Systematic reviews of clinical trials start with high quality (level 1), while reviews of observational studies start with low quality (level 4). The aspects that can lower the quality of a randomized controlled trial are: Risk of bias, inconsistency of the results, indirect evidence, imprecision of the results and publication bias. Observational studies, although they can lower quality with the aforementioned aspects, also they can increase it if they include some favorable methodological aspects. The three aspects that can increase the quality of are the presence of a large effect size (Relative Risk, >2.0 or <0.5); evidence of a gradient dose-response relationship and the absence of residual bias or confounding factors (15–20).

The quality of the evidence is related to the confidence that the true effect is close to the estimated effect. Four levels are defined: very low, low, moderate and high (11). Most of the quality of the evidence for this guideline was low or very low quality of evidence.

From Evidence to Recommendation

Following the GRADE system, the elaboration of the recommendations does not only take into account the quality of the evidence, but also a series of aspects or judgments based on the following criteria: The priority of the problem, the magnitude of the desirable and undesirable effects, the certainty of the evidence, the values of the interested parties, the balance between desirable and undesirable effects, the resources required, the cost-effectiveness, equity, acceptability and feasibility. With these criteria, a summary table of judgments was created and the direction and strength of the recommendation were defined (21). The strength of the recommendations is rated in four categories: Strong (recommended to do), weak in favor (suggested to do), strong against (recommended not to do), weak against (suggested not to do) (21). During face-to-face sessions with the entire guideline development group, the evidence for each question, the quality of the body of evidence, and the judgments were presented. With the foregoing, a recommendation was drawn up that was subsequently validated by an extended group with thematic experts and representatives of scientific societies and universities.

Economic Evaluations

Five economic evaluations were made during the development of the CPG to assess the cost-effectiveness of five of the interventions and help the guideline development group in the decision-making.

Consumer Preferences

In the development of a CPG, it is recommended including the perspective of the patients for the preparation of the recommendations. Thus, people with lower limb amputation were invited to define their priorities in three categories: complications, activities and prosthetic adaptation; using the GRADE methodology. In addition, their preferences of the treatment options in the recommendations with greater uncertainty and with low quality of evidence were evaluated.

Between July and November 2014, people with amputation in two institutions that provide health services in two cities of the country were invited. The inclusion criteria were people from 18 to 65 years old, who had a major lower limb amputation of any level and cause and who could attend a meeting with the researchers. Children and upper limb amputees were excluded. A convenience sampling was used, with the people who responded to the call. The objectives of the CPG and their participation,

TABLE 1 | Example of the search strategy and results in data bases for one of the CPG questions in the 2018 update.

DB	Search strategy
PubMed 328	(Amputation[MeSH] OR Amputation, Traumatic[MeSH] OR traumatic amputat*[tiab]) AND (Lower Extremity[MeSH] OR Leg Injuries[MeSH] OR lower limb[tiab] OR LLA[tiab]) AND (Disarticulation[MeSH] OR Replantation[MeSH] OR Limb Salvage[MeSH] OR salvage[tiab] OR reconstruction[tiab] OR disarticulation[tiab]) AND (("2015/01/01"[PDat]: "3000/12/31"[PDat]))
Embase 67	('amputation'/exp OR 'amputation' OR 'traumatic amputation'/exp OR 'traumatic amputation' OR 'diabetic foot'/exp OR 'diabetic foot') AND ('reimplantation'/exp OR 'limb salvage'/exp) AND ([cochrane review]/lim OR [systematic review]/lim OR [controlled clinical trial]/lim OR [randomized controlled trial]/lim OR [meta-analysis]/lim) AND [2015-2018]/py
Cochrane 13	[Amputation] explode all trees OR [Amputation Stumps] explode all trees OR [Amputation, Traumatic] explode all trees OR [Amputees] explode all trees AND [Limb Salvage] explode all trees OR [Replantation] explode all trees. Since 2015

PECOT question: In patients over 16 years old with severe lower limb trauma, is reconstruction of the limb compared to amputation at any level more effective and safer to achieve better function, return to work, reduce the need for additional surgical procedures, infection or residual pain in the first 12 months after surgery?

the instruments that were applied and doubts were resolved were explained at the meeting. In the group of 20 patients studied in one of the cities, the preferences of the CPG questions in which there was greater uncertainty at the time of presentation of the evidence synthesis were also evaluated.

RESULTS

Literature Search

One search strategy is presented as an example in **Table 1**, for one of the surgical recommendations, elaborated during the updating of the CPG. All the other search strategies can be consulted in the complete document of the CPG (8).

GPC Recommendations

Forty-three recommendations were made. Nine on the decision of amputation; five on preoperative interventions including: preoperative regional analgesia, cardiovascular reconditioning, psychological support, prophylactic antibiotics, and intraoperative tourniquet use; ten on amputation techniques; ten on the components of the prosthesis, feet, knees, sockets, liners, as well as orthoses for partial amputation and the adaptation of immediate postoperative prostheses. Nine for the post-prosthetic phase, including functioning scales to evaluate the use of prostheses; treatment for neuropathic and phantom limb pain; cardiopulmonary, physical and occupational rehabilitation; ergonomic adaptations and psychosocial interventions. Comprehensive rehabilitation compared to the usual care model was also evaluated and this was a strong recommendation in favor. The synthesis of the quality of the evidence and the strength of the recommendations can be seen in **Table 2**, and **Figures 1**, **2**.

The distribution of the 43 recommendations, according to the quality of the evidence, was: high 0%, moderate 7.5%, low 57.5%, very low 35%. And according to the strength of the recommendations, their distribution was: Strongly in favor 37.2%; weak in favor 53.48%; strong against 2.32%; weak against 6.97%. In updating the prioritized questions, a recommendation changed from Weak in favor to Strong in favor, leaving the distribution as follows: Strong in favor 58.3%, weak in favor 41.6%.

Consumer Preferences

As part of the participation of patients in the development of the CPG, they were invited to assess the importance of each outcome of the recommendations (22). Patients chose stump infection in 31.7%, death in 22%, stump reoperation in 22%, and phantom pain in 12.2% as the most important outcomes for them. The most important activities in the rehabilitation process were walking in 51.2%, returning to work in 17.1%, having a good quality of life in 14.6% and participating in social activities in 7.3%. Twenty patients participated in the evaluation of preferences. Of them, 95% prefer to keep the knee to a transfemoral amputation, 60% prefer amputation in the first surgery than reconstruction, 75% agree with the need for psychological support, 85% agree with a supervised exercise plan after amputation and, only 45% agree with the use of an immediate prosthesis (22).

Economic Evaluations

The results of the first economic evaluation concluded that, after a careful selection of patients and intervention by a multidisciplinary team, limb reconstruction was a dominant strategy compared to primary amputation in the long term (23).

In the second evaluation, the adaptation of an articulated foot was not a cost-effective strategy compared to a SACH foot, in patients with a low level of activity (8).

In the third, in a sample of 113 patients analyzed in a cross-sectional study, the total contact socket was a cost-effective strategy compared to a patellar-tendon-bearing (PTB) type (8). However, it is not possible to determine if this result can be extrapolated to other populations of patients with amputations below the knee in Colombia.

In the fourth economic evaluation, Pregabalin was found to be the strategy with the greatest net benefit, so it can be considered first-line treatment of phantom pain or residual pain in lower limb patients with amputation (24). Gabapentin and amitriptyline had similar, albeit lower, net benefits and could also be considered at the discretion and experience of the treating physician. More research is needed on the effectiveness of medications in patients with lower limb amputation.

In the fifth economic evaluation on the cost-effectiveness of prophylactic antibiotics, it was found that this is a dominant strategy and it is unlikely that the uncertainty surrounding the costs and benefits changes the results, the use of this intervention is recommended in Colombia (25).

TABLE 2 | Recommendations with quality of evidence and strength of recommendation ($n = 43$).

		Recommendation				Quality of the evidence			
		Strong in favor	Weak in favor	Strong against	Weak against	Very low	Low	Moderate	High
AMPUTATION DECISION AND ITS LEVEL. TRAUMA									
1	The use of any scale (MESS, NISSA, PSI, LSI and HFS-97) is not suggested in patients over 16 years old with lower limb trauma to define the type of intervention								
2	The use of any scale (MESS, NISSA, PSI, LSI and HFS-97) is not recommended in patients over 16 years old with lower limb trauma to predict function								
3	Soft tissue reconstructive procedures, flaps or grafts, are suggested for the treatment of soft tissue coverage defects of the amputation stump below the knee to preserve this joint and maintain a level of transtibial amputation								
4	Limb reconstruction is suggested in patients over 16 years old with severe lower limb trauma rather than amputation								
AMPUTATION DECISION AND ITS LEVEL. VASCULAR									
5	It is suggested to measure the transcutaneous oxygen tension to complement the surgeon's clinical decision.								
6	Plethysmography along with digital systolic blood pressure and ankle systolic blood pressure is suggested if transcutaneous oxygen tension is not available to supplement a surgeon's clinical assessment								
7	Two-stage amputation rather than single-stage amputation with primary closure is recommended for patients who require lower limb amputation secondary to moist necrotizing gangrene and severe infections								
AMPUTATION DECISION AND ITS LEVEL. DIABETES									
8	It is suggested to use the Texas or Wagner classification in patients with diabetic foot ulcers to predict the risk of amputation in clinical practice								
9	Transtibial amputation is suggested in patients over 16 years old who require amputation of the lower limb secondary to neuropathic or vascular disorders to reduce the risk of reamputation in the first 12 months								
PREOPERATIVE INTERVENTIONS									
10	Perioperative epidural analgesia is suggested in patients over 16 years old for lower limb amputation surgery to reduce acute stump and phantom limb pain in the postoperative period								
11	A preoperative cardiovascular reconditioning program is recommended in patients with vascular disease who are at risk of lower limb amputation.								
12	Preoperative psychological support is suggested in patients with vascular disease who are at risk of amputation.								
13	The use of prophylactic antibiotics is recommended for not longer than 24 h after amputation to prevent infection of the stump								
AMPUTATION TECHNIQUES									
14	The use of an intraoperative tourniquet is suggested in patients who require a transtibial amputation due to traumatic, ischemic or diabetic causes								
15	Amputation of the midfoot or hindfoot is suggested in patients with two or more rays affected due to ischemic causes or diabetes								

(Continued)

TABLE 2 | Continued

		Recommendation					Quality of the evidence		
		Strong in favor	Weak in favor	Strong against	Weak against	Very low	Low	Moderate	High
16	Performing a Syme amputation that allows adequate coverage, mobility, and function is suggested in patients who require a distal amputation due to vascular or metabolic etiology								
17	It is suggested that the choice of transtibial amputation flap be a matter of surgeon preference taking into account factors such as prior experience with a particular technique, the extent of non-viable tissue, and the location of pre-existing surgical scars								
18	The conventional technique (without distal tibiofibular bone bridge) is recommended instead of the modified Ertl (with tibiofibular bone bridge), in patients who require a transtibial amputation, due to traumatic, ischemic or diabetic causes								
19	It is recommended to guarantee adequate soft tissue coverage in the transtibial amputation stump in patients requiring amputation due to traumatic or vascular etiology, to allow an adequate balance of muscular forces, avoid shearing of the flaps and improve the stability of the stump within of the prosthesis; this coverage can be obtained with myodesis or myoplasty techniques								
20	A transfemoral amputation rather than a knee disarticulation is suggested for patients older than 16 years who require a lower-limb amputation and are not candidates for below-the-knee amputation								
21	Myodesis of the amputation stump is recommended in patients who require a transfemoral amputation due to traumatic or vascular etiology								
22	It is recommended when performing a transfemoral amputation to obtain a bony stump of at least 57% of the length of the contralateral femur in patients who require a transfemoral amputation for traumatic, ischemic or diabetic causes								
23	It is suggested to close the skin of the amputation stump in the lower limb with non-absorbable monofilament sutures, in patients who require amputation due to traumatic or vascular causes, to reduce the risk of surgical complications								
24	The use of closed suction drainage systems after definitive closure is not routinely suggested in patients who require amputation of the lower limb for traumatic, ischemic or diabetic causes, to reduce the risk of infection and the need for additional surgeries. by bruises or seromas								
PROSTHETICS									
25	The use of an immediate postoperative prosthesis is suggested in patients with lower limb amputation due to traumatic and vascular causes, to improve the remodeling of the stump								
26	Fitting an orthopedic insole or orthosis is recommended for people with partial foot amputations								
27	It is recommended for people with an amputation above or below the knee and a low expected functional level (K1/K2), the adaptation of a SACH foot								

(Continued)

TABLE 2 | Continued

		Recommendation					Quality of the evidence		
		Strong in favor	Weak in favor	Strong against	Weak against	Very low	Low	Moderate	High
28	The adaptation of an articulated foot or a dynamic response foot is suggested in people with higher activity requirements (K3/K4) or who must use the prosthesis on irregular or inclined surfaces, recommended by a specialist doctor with training in the area of prosthetics and social or environmental conditions make it possible								
29	The fitting of a full contact socket prosthesis with a silicone sleeve is suggested for below-knee amputees								
30	A prosthesis with a full contact socket with a liner in silicone, copolymer or polyurethane is suggested for people with amputation below the knee. The use of a vacuum valve or a pin and lock system must be individualized								
31	In people with amputation above the knee and an expected functional K1 level, the adaptation of a monocentric knee with manual locking or with a load brake is suggested, in K2, K3, and K4 a monocentric or polycentric fluid control								
32	In people with knee disarticulation and an expected functional level of K1, the adaptation of a mechanical polycentric knee for knee disarticulation is suggested; and in K2, K3 and K4 a fluid control polycentric								
REHABILITATION									
33	In people with an above-knee amputation and moderate or high functional levels, the adaptation of one of the ischial containment socket variants is recommended. In people with low functional levels, the adaptation of a quadrilateral socket is recommended								
34	For above-knee amputees, individualized adaptation of a suspension system is recommended based on the patient's functional capabilities and residual limb condition								
35	In patients with lower limb amputations due to trauma, vascular or diabetes, the use of one or more of the scales (PEQ-MS, 2MWT, TUG and SIGAM) is suggested for the evaluation of musculoskeletal function and movement								
36	The use of the Houghton Scale is suggested to assess prosthetic adaptation in patients who had a lower limb amputated due to traumatic, vascular or diabetic causes								
37	It is not suggested to use neuropsychological therapies (mirror therapy) in patients with lower limb amputation due to traumatic, vascular or diabetic causes, for the improvement of phantom limb pain								
38	Pregabalin is recommended first, followed by gabapentin, amitriptyline, and duloxetine as monotherapy, in amputated patients due to trauma, vascular causes, or diabetes to improve neuropathic pain								
39	The implementation of a cardiopulmonary rehabilitation program is suggested in patients with lower limb amputation due to traumatic, vascular or diabetic causes								
40	The implementation of a physical rehabilitation program that includes muscle strength, joint mobility, balance, gait, physical reconditioning is recommended in patients with lower limb amputation, due to traumatic, vascular or diabetic causes								

(Continued)

TABLE 2 | Continued

		Recommendation				Quality of the evidence			
		Strong in favor	Weak in favor	Strong against	Weak against	Very low	Low	Moderate	High
41	Occupational rehabilitation and ergonomic adaptations are recommended in patients with lower limb amputation due to trauma, vascular or diabetes, to improve functioning and facilitate return to work or an occupation								
42	Post-prosthetic psychosocial interventions in which the patient and their family are involved are recommended in patients who have had a lower limb amputated due to traumatic, vascular or diabetic causes								
43	The implementation of a comprehensive rehabilitation process is recommended: cardiopulmonary, musculoskeletal, psychosocial, activities of daily living and for work, in patients with lower limb amputation, due to traumatic, vascular or diabetic causes								

Recommendationn

Strong in favor
Weak in favor
Strong against
Weak against

Quality of the evidence

Very low
Low
Moderate
High

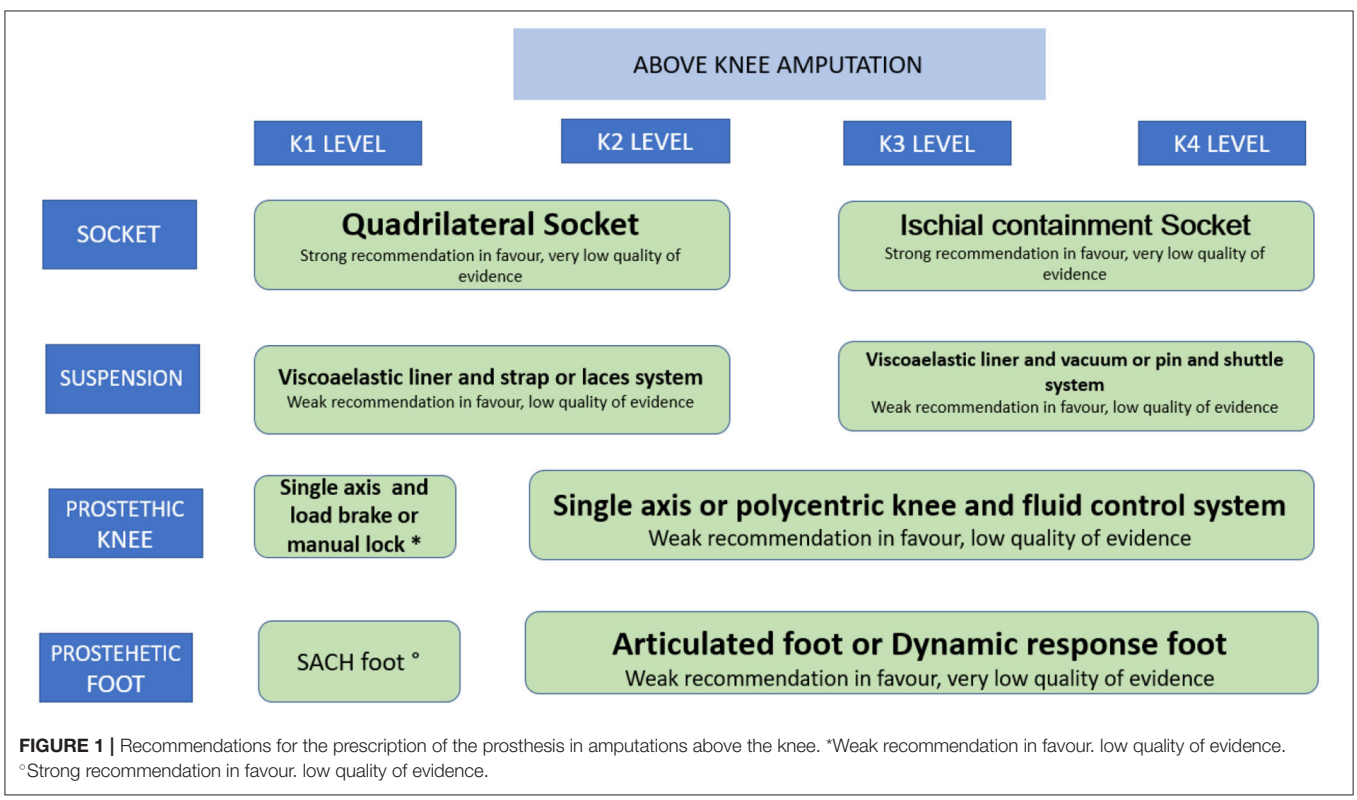

FIGURE 1 | Recommendations for the prescription of the prosthesis in amputations above the knee. *Weak recommendation in favour. low quality of evidence. °Strong recommendation in favour. low quality of evidence.

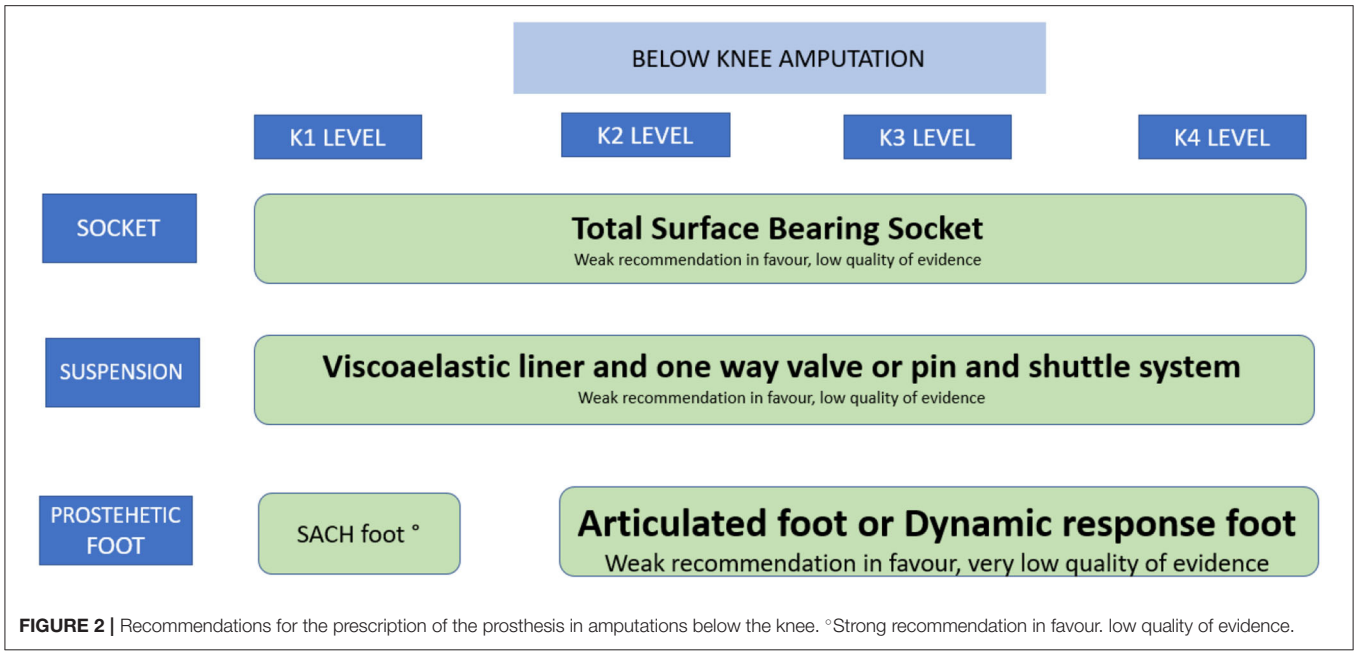

FIGURE 2 | Recommendations for the prescription of the prosthesis in amputations below the knee. °Strong recommendation in favour. low quality of evidence.

Implementation Plan

As a final result of the CPG, the implementation process was described based on planning, implementation activities, monitoring and evaluation. Structure, process and outcome indicators were defined. Structure indicators were the availability of surgical and rehabilitation services. Process indicators were the proportion of patients with prostheses and in a rehabilitation program, according to the recommendations of the guidelines. Outcome indicators were the proportion of patients with reamputation, the proportion of patients adapted to prosthesis, and the proportion of professionals who follow the recommendations of the CPG.

DISCUSSION

This article described the methods and results of the elaboration of an evidence-based CPG for the care of people with lower limb amputations.

The elaboration of the CPG started with the formation of a multidisciplinary group that received training in methods form international and national universities and centers. The guideline included 43 recommendations, where nine were about the amputation decision and the level of amputation; five on preoperative interventions; 10 on amputation techniques; 10 on prosthetic components and nine on post-prosthetic rehabilitation. In 93% of the recommendations, the quality of the evidence was between low and very low. This is why it was so important, on a permanent basis, to validate and discuss each recommendation with an expanded multidisciplinary group with experience in treating lower-limb amputees. The socialization was carried out with different actors interested in the care of these patients.

This CPG was evaluated by international experts using the AGREE II instrument, with a score of 94/100, and was recommended for its implementation in Colombia. During the development, other CPG were evaluated, in which the scope and purpose domain had scores between 65.3 and 98.6%; in the stakeholder involvement between 54.1 and 97.2%; in the rigor of development between 25.0 and 85.9%; in the domain of clarity of presentation between 62.5 and 95.8; in applicability between 18.8 and 93.8%; and in editorial independence between 14.1 and 7.9% (8). This is in agreement with an article that evaluated the quality of the evidence of four CPG with 217 recommendations and found that the quality of the evidence was low (26). In addition, in the rehabilitation questions only 6.9% came from randomized clinical trials (RCT), systematic reviews or meta-analyses.

Although there were three CPG that had a score >60 in the methodological domain of the AGREII rating (27–29), they were not adapted because many of the questions raised by the developer group did not coincide with the questions of the guidelines. And the second reason was because the methodological guideline of Colombia (7) recommends that the guidelines in Colombia must be developed with the GRADE methodology and the guidelines did not follow this methodology at the time of the CPG search.

The research group identified 25 interventions and five milestones to be prioritized in the implementation. The milestones included re-amputation, reinterventions due to infectious processes, prosthetic adaptation, return to work and independence in activities of daily living (30).

We conducted a stakeholder's dialogue as a mechanism for the external validation of the Guideline implementation (31). Fifty-four actors participated in this forum, including: professionals from the MoH, representatives from health insurance companies, health provider institutions, academic

professionals, scientific associations and thematic experts from different areas, patients, undergraduate and postgraduate students. In this dialogue participants emphasized the need to build integrated rehabilitation programs that are close to the patients in order to guarantee access to the health services with the minimum displacement of the patient. It is important to include care in the area of mental health. Successful prosthetic adaptation also depends on family support, training in activities of daily living, modification of the home and community environment, and occupational reintegration. Users must be guaranteed that they have sufficient and timely information, and continuous training, so that they are active actors in their surgical and rehabilitation process, through knowledge of their rights.

Insurers must recognize their responsibility in the care, rehabilitation and risk management of their insured population. Extramural actions must be included that allow the decentralization of rehabilitation services.

For the stakeholder participants it is important to have an information system for all personnel in charge, and to be able to measure the quality of care and the outcomes in patients. The referral and counter-referral process should be strengthened so that patients residing in rural and dispersed areas can access services in the main cities. In addition, implement a system in which patients are referred to centers where their needs can be effectively responded to. It is important for the country to involve these aspects in medical training and related professions, as well as continuing education for professionals involved in patient care, including evidence-based medicine and CPG training.

Several facilitators must be involved to improve patient accessibility such as technological tools, telemedicine and tele-rehabilitation (32, 33). These strategies were strengthened during the SARS2 COVID 19 pandemic.

The most important barriers and facilitators found in a qualitative study made by the research group and that were decisive for the implementation of the CPG for amputees included challenges related to the governance and financial arrangements of the Colombian health systems (34). For example, the Colombian health system could mandate that health care institutions establish procedures to adapt CPGs for amputee patients. At the time, health institutions are only required to have CPG for the most 10 prevalent health conditions; and amputations do not meet that requirement. Regarding financial arrangements, policymakers could ensure that access to the promotion, prevention, diagnosis, treatment, and rehabilitation of individuals with amputations does not depend on the type of patient insurance (34). In the systematic meta-review, there was greater emphasis on the barriers related to professionals, such as lack of credibility in the evidence, lack of training in CPG, the absence of a leader, and difficulties with the work team. Patients identified the lack of information from health professionals as difficulties, expressing the need for prostheses to be adapted according to their context (35).

The results of investments in research and training of health personnel to improve the quality of care are not being taken into account in health practice settings and many patients are not receiving the best possible care. This represents a gap between medical advances and clinical practice. Similar findings have been reported around the world in both developed and developing settings, in primary and specialty care (1).

Implications for Practice and Policy

For health professionals in charge of caring for amputees, it is important to emphasize the need for patients to receive the most effective and safe interventions. Patients need to receive this intervention in time to reduce functional limitations and achieve occupational reintegration and social participation for amputees.

Rehabilitation services must be comprehensive and available in a place that is close to patients to reduce the possibility of loss in the continuity of care. In the country, travel is paid for by patients and their families and this can be an even greater barrier if they must go to different places for their treatment. Comprehensive rehabilitation must involve mental health aspects to prepare amputees in the phase of acceptance and mourning for the loss of their limb and provide support in rehabilitation. Also, comprehensive rehabilitation must include physiatrist care, physical and occupational therapy, cardiopulmonary rehabilitation, psychology care and very importantly access to the prosthesis and its adaptation. All of the above will make possible for amputees to return to their usual occupation and integrate into society.

Professionals must have the necessary training, time and incentives to achieve a change in professional practice.

Implications for the Health System and Policies

In Colombia, administrative procedures with insurers companies are lengthy and amputee patients must take multiple steps to obtain approval for each of the interventions and devices necessary for their rehabilitation (36, 37). The rehabilitation program should be approved as a package of interventions based on the recommendations of the CPG.

Limitations and Strengths

One limitation of the study is not having the final results of the implementation project to make better analyzes of the situations presented.

CONCLUSIONS

It is not enough to prepare a CPG of very good quality, to elaborate a comprehensive health care pathway and to assess the barriers and facilitators for recommendations implementation, to improve the healthcare process of people with lower limb amputations in Colombia. It is necessary to develop a national policy that promotes the necessary arrangements for the provision of services as coordination of care amongst different providers, communications between them, continuity of care, package of care, referral systems, shared care, multidisciplinary teams, planning the transition of care from hospital to the community, health information systems development. Financial and governance arrangements and finally implementation strategies targeted at healthcare organizations, at healthcare workers, and in a specific type of practice.

AUTHOR CONTRIBUTIONS

All authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript.

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OPINION
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The Burden of Disability in Africa and Cameroon: A Call for Optimizing the Education in Physical and Rehabilitation Medicine

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INTRODUCTION

Physical and Rehabilitation Medicine (PRM) is the medical specialty of body functioning. Its aim is to diagnose, prevent and reduce disability resulting from the interaction between people and their environment (1, 2).

The World Health Organization (WHO) Global Disability Action Plan 2014–2021 "Better health for all people with disabilities" is a significant step toward rehabilitation services. For a successful implementation of the WHO recommendations, PRM organizations and individual PRM specialists are urged to contribute to the improvement of PRM services worldwide (3).

The International Classification of Functioning, Disability and Health (ICF) provides a widely accepted conceptual model and taxonomy of human functioning (1).

PRM specialists guarantee the citizen's access to rehabilitation services as a human right (4–6).

It is well-known that rehabilitation is essential to lower healthcare costs by decreasing the number of days spent in hospital, and that reducing disability improves quality of life. Varela et al. highlight the need for more scientific studies on the benefits of rehabilitation even in the preoperative phase, while we know that current studies confirm that early postoperative rehabilitation decreases pain and its consequences (7).

In long-term disabilities, the rehabilitation process for patients with complex problems requires a carefully planned and integrated program by the PRM physician who provides advice on diagnosis, prognosis, treatment options and risks for the patient and family. The PRM physician must take his leadership role over the rehabilitation team, as well as assist in the development of treatment protocols; his holistic perspective on long-term rehabilitation management makes a unique contribution (8).

High-quality rehabilitation care is a constituent element of healthcare systems worldwide. The implementation of these standards needs to be validated worldwide with particular attention to low- and middle-income countries. The standardization of staff training at both undergraduate and postgraduate levels is a key element in ensuring the highest standard of rehabilitation care. International bodies, such as the UEMS Board for PRM or the International Society for PRM, have already delivered normative documents setting standards in postgraduate PRM training.

They highlight the need to develop competency-based education, training physicians with the proper skills and knowledge required to meet the healthcare needs of people with disabilities, as a powerful mechanism to align education and training with health system priorities.

This is of particular value for countries with limited resources, where the knowledge and skills of rehabilitation physicians need to reflect not only the health profile of the population, but also the strengths and weaknesses of the health system.

THE BURDEN OF DISABILITY IN AFRICA AND CAMEROON

As life expectancy increases, disability rates caused by the diseases listed above increase (9, 10).

The World Disability Report published by WHO in 2011 also states that the prevalence of severe and moderate disability is higher in Africa than in many other regions of the world especially in younger (<60 years) population groups (11). It is assumed that the causes are related to infectious diseases and injuries although the literature has limited evidence (12, 13).

A number of publications report a prevalence of disability in the general population ranging from 1.7% in Mali (14) to 17.1% in Sierra Leone (15), but it should be noted that these studies have used different methodologies and tools.

Disability prevalence in Cameroon was recently estimated in a survey of a sample of 1,617 adults aged 18+ using the Washington Group tools, which capture self-reported activity limitations in functional domains described in the ICF (16). There are several Washington Group modules recommended for adult populations: Short Set (6 items focusing on a subset of "core" functional domains such as seeing, hearing, mobility, memory/concentration, self-care, and communication); Labor Force Survey Disability Module (additional domains of anxiety and depression, 10 items); Short Set Enhanced (additional domain of upper body strength, 12 items); Extended Set on Functioning (additional domains of pain and fatigue, 17 items). The standard pre-determined threshold recommended for calculating internationally comparable disability prevalence data is to include anyone reporting a lot of difficulty or inability to do in any domain, and a wider threshold (some difficulty or worse) is often reported too. The prevalence of disability in this population tended to increase as modules were included with an additional number of items and using a wider threshold of functional limitations. Based on the Short Set, it ranged from 6.1% using the standard threshold to 66.3% using the wide threshold; based on the full Extended Set on Functioning, it ranged from 12.9% using the standard threshold to 71.0% using the wide threshold.

A study in a health district in Cameroon showed that many disabilities, such as orthopedic problems (mainly fractures), infectious diseases and neurological disabilities (mainly hemiplegia, hemiparesis and monoplegia), were due to traffic accidents and inappropriate medical interventions (17). In Mali congenital abnormalities, trauma, polio and leprosy were reported to be the most common causes (14), while in Liberia mental health disabilities were related to war and postwar experiences (18).

A large number of studies explored the effect of disability on health, education, social participation and livelihoods of people with disabilities.

Adults with disabilities were more likely to experience serious health problems and report limited access to healthcare and rehabilitation services (19).

A literature review published in 2018 on five West African countries defined important policy and program implications as follows:

(1) Application of standardized tools for monitoring the implementation of programs and policies at national level;
(2) Improving stakeholder coordination mechanisms at the country level;
(3) Supporting countries in using unified approaches to measuring disability and social exclusion;
(4) Strengthening the rigor of the evaluations of the effectiveness of disability-specific interventions;
(5) Disaggregation of routine data from development programs by disability (10).

A disability research team established the need to define strategies to improve the activities of daily living of people with disabilities in Cameroon (20).

A descriptive cross-sectional study pointed out that disabled people, and children in particular, are still marginalized, vulnerable and with little chance of recovery. Therefore, there is a clear need to improve the quality and availability of rehabilitative care with programmatic interventions that improve the accessibility to rehabilitation services for people with disabilities, provide them with the necessary safeguards, ensure implementation of existing laws, and neutralize any barrier to their social participation (21).

Regarding disability associated with human immunodeficiency virus (HIV) infection, a 2019 study shows that antiretroviral therapy improves impaired immune function. It is reported in the literature that physical (aerobic/endurance) exercises also seem to induce beneficial effects (22).

In another 2019 study, Ibeneme et al. argue that while aerobic exercise does not improve levels of inflammatory biomarkers (IL-6 and IL-1β), it does significantly improve cardiopulmonary function in HIV-infected patients (23).

The importance of rehabilitation medicine is also evident from a 2019 literature review on HIV-infected children with impairments and disabilities. Unfortunately, we know that pediatric health systems in Sub-Saharan Africa are not integrated with rehabilitation in chronic diseases such as HIV while integration to pediatric Rehabilitation in a holistic approach would be important. This scoping review proposes a synthesis of existing evidence on rehabilitation intervention strategies for disability-related barriers in children living in Sub-Saharan Africa (24).

The incidence of diabetes mellitus (DM) in Africa is not only a health problem but also imposes a significant economic burden. Diabetic peripheral neuropathy is a common microvascular

complication of DM that increases the potential for morbidity and disability due to ulceration and amputation. Based on the study analysis, the highest prevalence of diabetic peripheral neuropathy in patients with DM was reported in West Africa at 49.4%. The need for a rehabilitation medicine approach also has its importance here (25).

Despite concerns about underreporting of cerebral palsy (CP) in many African communities, the prevalence estimates reported here were generally higher than the estimated 2–2.5 of 1,000 in most studies conducted in the United States or Europe (26). It is likely that in Africa the prevalence of CP is high because of the level of perinatal complications such as birth asphyxia and neonatal infections. What is clear is that there is a lack of screening policy for disabilities among infants and pre-school children in Africa (27).

There is a paucity of studies in Africa, South-East Asia and the Eastern Mediterranean region on pulmonary diseases, with increasing prevalence of chronic obstructive pulmonary disease, both globally and regionally (28).

In the same way patients with idiopathic pulmonary fibrosis (IPF) generally experience poor quality of life. A study reports that these patients are poorly referred to palliative care even in developed countries, while in developing countries no data are available on the use of palliative care or the burden of health care management. Therefore, more awareness and research on the palliative care needs of patients with IPF is recommended, particularly in resource-limited settings such as South Africa (29).

About the burden of stroke in Africa, the results of a review suggest that is high and still rising. The incidence of stroke in Africa is becoming a public health challenge; unfortunately scarcity of data has limited research and consequently also the response to the exact public health burden.

In 2019, a total of 1.89 million stroke survivors were estimated among people aged 15 years or older in Africa. There is a need for extensive research on both stroke and other vascular risk factors to institute appropriate policy, and effective preventive and management measures (30).

Regarding the rheumatologic diseases, a systematic review identified the paucity of latest prevalence data on arthritis in Africa (31).

After this excursus of the most important diseases that afflict the African continent, this systematic review of the empirical literature, from 2016, emphasizes the importance of exploring the sustainability of health interventions in Sub-Saharan Africa.

From the analysis of these studies, we can define the importance of rehabilitation and the need for more studies in this area (32).

For the application of proper rehabilitation in the field of PRM, a study emphasizes the need to understand the current learning styles of physiotherapy students and if necessary also change the teaching styles in order to provide high quality education. Currently, physiotherapy students have specific learning styles of active participation supported by practical internship activities and theoretical concepts. Further research would be fundamental to define and standardize learning styles in physiotherapy courses (33).

The results of a study published in 2009 offer the first global portrait of the dynamics of demand and supply of human resources for rehabilitation: the lowest supply of rehabilitation health professionals was found among low- and middle-income countries, many located in Sub-Saharan Africa, where the burden of cause-related diseases requiring rehabilitation professional skills tends to be greatest. Worldwide, people with disabilities have many unmet health and rehabilitation needs but continue to face significant barriers in accessing mainstream health services, and consequently have poorer health outcomes. Currently, a double burden is found in low- and middle-income countries. Unfortunately, human resources for rehabilitation are often a neglected component of health services (34).

DISCUSSION

In light of what has been examined so far, we discuss the current situation of disability and PRM in the Cameroon healthcare system and their possible perspectives.

Where Is Disability in the Cameroon Healthcare System?

Healthcare system promotes equity in people. In addition, WHO reported that people with disabilities are also entitled to attain the best possible quality of care without discrimination. In the same vein, Cameroon has signed and ratified numerous national and international conventions on disability with the aim to attain a number of privileges for disabled persons, which have been recently characterized by Foti et al. (17). It is including medical, material, financial and psychosocial assistance and other forms of assistance depending on the degree of disability. However, in practice Cameroon faces to several challenges of poor health system like other countries in Africa (17). Relative lack of a value-based reimbursement system for care act in general population, dearth of specialized medical structures and inadequate health care for disabled persons in Cameroon are the most noted. To address these challenges of poor health outcomes, the Cameroon healthcare system has established the Affordable Care Act, which aims to lower costs and improve quality. Also, to answer this situation, training physicians in PRM is an opportunity.

PRM Within the Cameroon Medical System

Rehabilitation aims to optimize functional ability, enhance quality of life and reduce disability in people with impaired health conditions through interventions. According to the WHO, countries with the lowest levels of health (and education) fail to sustain real growth and development (35, 36). Are physicians in Cameroon prepared to adequately prescribe exercise-based rehabilitation?

The current Cameroon medical system woefully underprepares clinicians to efficiently prescribe exercise-based rehabilitation. In addition, the majority of fellowships offer no training in exercise prescriptions. In Cameroon, the PRM curricula are not available in the existing medical schools. However, general physiotherapy and/or rehabilitation, speech therapy, occupational therapy, orthoprosthesis and

psychomotricity programs are offered by some universities and institutions in Cameroon as elective teaching modules. Therefore, PRM as a medical specialty is not well-known.

Education and Research in the Field of PRM in Cameroon: Call to Action

Curriculum is an initial step for the development of any field and guide health research. In Cameroon, research in the field of rehabilitation also suffers. Thus, we propose some following points for a call to action to implement and disseminate this impactful discipline in Cameroon:

(1) Develop a 4-year higher specialty training program in PRM;
(2) Gain recognition of the new specialty in Cameroon by the Ministry of Higher Education;
(3) Establish a system such as training and research in rehabilitation to ensure continuity competence of physicians practicing PRM in Cameroon, according to recommendations and standards provided by international PRM boards: "To acquire the wide field of competence needed, specialists in Physical and Rehabilitation Medicine have to undergo a well-organized and appropriately structured training of adequate duration. In fact they are required to develop not only medical knowledge, but also competence in patient care, specific procedural skills, and attitudes toward interpersonal relationship and communication, profound understanding of the main principles of medical ethics and public health, ability to apply policies of care and prevention for disabled people, capacity to master strategies for reintegration of disabled people into society, apply principles of quality assurance and promote a practice-based continuous professional development" (37, 38).

CONCLUSION

We can confirm that high-quality rehabilitation care is essential within health systems, especially for low- and middle-income countries. The importance of adapting staff training both at university and post-graduate level is a fundamental element to ensure the highest standard of rehabilitation care.

The review carried out on the literature relating to the main diseases that cause disabilities in Africa with particular regard to Cameroon highlighted shortcomings in the health systems both at a social and welfare level; for this reason, the aim is to define training courses and strategies that can guarantee the best level training to provide better intervention systems for professionals in PRM. This is why the international bodies of PRM highlight the need to develop training that allows education to be aligned with the priorities of the health system.

As regards Cameroon, a fundamental aspect would be to recognize the specialization in PRM by the Ministry of Higher Education, developing a 3 or 4-year educational program and improving scientific research in this field.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Telerehabilitation as a Method for Achieving Competencies in Physical and Rehabilitation Medicine Residency Training in a Developing Country: A Protocol for a Pilot Mixed-Methods Study

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Background: In the second year of the COVID-19 pandemic, Physical and Rehabilitation Medicine (PRM) residents in a developing country continue to face a lack of in-person clinical exposure and learning opportunities. With the unprecedented shift to virtual care, it remains uncertain whether residents can achieve PRM competencies using telerehabilitation as a method of instruction.

Objective: To determine the PRM residents' ability to achieve competencies through telerehabilitation, as perceived by different stakeholders (residents, chief residents, training officers, and department heads).

Methods: This will be a pilot mixed-methods study, employing concurrent triangulation, in the Department of Rehabilitation Medicine in one large private medical center and one large government hospital in Manila, Philippines. There will be two phases of online data collection upon approval by their respective research ethics board. The first phase will involve an online Likert-scale questionnaire to obtain the residents' self-perceived attainment of competencies and learning of PRM topics and skills specified by the International Society of Physical and Rehabilitation Medicine and the Philippine Board of Rehabilitation Medicine. The results of the survey will then be summarized and presented in a focus group discussion (FGD) with the department heads, training officers, and chief residents of the two institutions in an attempt to explain the residents' perceptions on their competencies achieved through virtual care. Afterwards, the qualitative data obtained from the FGD will then be thematically analyzed, and mixed methods integration will be employed to generate knowledge and recommendations.

Discussion: It is hypothesized that the majority of the residents had little to no experience with telerehabilitation pre-pandemic. Suddenly telerehabilitation was used to augment clinical training during the pandemic. It is uncertain whether telerehabilitation

can help residents achieve competencies in the different domains of training, namely: patient safety and quality patient care; medical knowledge and procedural skills; interpersonal and communication skills; practice- and systems-based learning and improvement; reintegration of people with disabilities into the society; medical ethics and public health; quality assurance; policies of care and prevention for disabled people; and professionalism. The study results can provide insights on the aspects of a PRM curriculum that may have to be modified to ensure the training program is sensitive and appropriate to the changing training needs of the residents amid the pandemic and similar crises that may disrupt in-person clinical encounters in the future.

Keywords: practice management, education, residency training, telehealth, telemedicine, telerehabilitation, COVID-19, rehabilitation medicine

INTRODUCTION

The sudden change in the landscape of Physical and Rehabilitation Medicine (PRM) residency training during the coronavirus disease 2019 (COVID-19) pandemic has caught its traditional curriculum (i.e., heavily reliant on in-person instruction) unprepared for the virtual mode of clinical teaching in various regions worldwide, especially wherein telehealth was not common. In the Philippines, which is a lower middle-income country that had one of the longest COVID-19 lockdowns (1), telerehabilitation was new to the majority of rehabilitation professionals, including physiatrists (2). Telerehabilitation, a subset of telehealth, is defined as "the delivery of rehabilitation services via information and communication technologies," enabling patient assessments and interventions from a distance (virtual care) (3). There is a growing evidence of telerehabilitation feasibility, effectiveness, safety, and user satisfaction for various disabling conditions, albeit more robust studies are necessary (4). Moreover, telerehabilitation also has an increasing role in providing experiential education to trainees faced with the lack of in-person patient encounters during the pandemic (5, 6).

Indeed, the COVID-19 pandemic has generally highlighted online learning in undergraduate and graduate health professional education; however its carry-over to actual practice remains understudied particularly for programs relying heavily on clinical training (7–9). Studies on students show that nothing can seem to replace seeing a patient in-person to develop clinical skills (7, 9). Nonetheless, given the urgency of the pandemic, some clinical training programs may have developed their guidelines for implementing and supervising virtual care (5, 6, 9), but there is a paucity in the literature regarding the success of these programs in ensuring the students achieve their intended clinical learning outcomes.

In the early part of the pandemic, the Philippine Academy of Rehabilitation Medicine (PARM) released interim guidelines on telerehabilitation to guide physiatrists toward incorporating virtual care in their practice and clinical teaching to ensure safety amid the pandemic (10). To address the lack of cases seen by PRM residents, the different training institutions had come up with various stop-gap measures applicable to their respective hospital policies and capacities. Among the temporary solutions of some institutions was telerehabilitation to help residents meet the required number of clinical hours, caseloads, and academic activities required by their respective hospitals and the Philippine Board of Rehabilitation Medicine (PBRM).

Because of the unprecedented transition to virtual or hybrid (i.e., mixed in-person and virtual) care, it is uncertain whether PRM residents are able to achieve the competencies expected of them based on the original pre-pandemic curriculum, which did not include telerehabilitation. There may be a need to revisit the curriculum of our respective training programs and determine which of its aspects (e.g., learning outcomes, topics, teaching-learning methods) have to be modified to incorporate virtual care and other online activities.

Therefore, the present study aims to answer the following research question: Are PRM residents able to achieve their competencies through telerehabilitation, as perceived by different stakeholders (residents, chief residents, training officers, and department heads) in two training institutions in a developing country that have suddenly incorporated virtual care in their program? The results of the study can guide these institutions, the national specialty board, and other PRM training programs around the world in revising the curriculum to ensure that it is sensitive and appropriate to the changing learning needs of trainees and flexible enough to stand the COVID-19 pandemic and similar crises that may disrupt in-person clinical training in the future.

METHODS

Research Design

A mixed-methods study design will be employed as part of a larger study aimed at developing a guide in using telerehabilitation as a teaching-learning tool to help PRM residents achieve their competencies. In this concurrent triangulation study, both quantitative and qualitative data will be obtained to provide complementary perspectives on the gaps in learning through telerehabilitation among PRM residents.

Study Population and Sampling Design

The study population will be a purposive sampling (total enumeration) of the following: (1) all current bona fide PRM

resident trainees across all 3-year levels at St. Luke's Medical Center - Quezon City (SLMC-QC) ($n = 5$) and Philippine General Hospital (PGH) ($n = 24$); (2) chief residents ($n = 2$); (3) training officers ($n = 2$); and (4) heads ($n = 2$) of the Department of Rehabilitation Medicine in the aforementioned hospitals. Inclusion criteria will include the following: (1) electronic informed consent; and (2) personal gadget with access to the Internet to be able to respond to an e-survey (i.e., Google Form™) or participate in an online focus group discussion (FGD) (i.e., Zoom™). Exclusion criteria will include the following: (1) on leave from residency training at the time of study; and (2) self-reported to be physically or psychologically unwell during the period of data collection. Withdrawal criteria will include the following: (1) unstable Internet connectivity despite several attempts resulting in inability to either submit responses to the online form or participate in the FGD; and (2) upon request by the FGD participant for any reason at all.

This will be a pilot study, as only two out of the six PRM residency training institutions in the Philippines will be included. The reasons for choosing PGH are as follows: (1) it is the largest government university hospital and longest-running PRM residency training institution in the country with the highest number of residents and graduates; (2) it can elicit unique experiences being a COVID-19 referral center; and (3) it has an established telerehabilitation service program since pre-pandemic. Meanwhile, the reasons for choosing SLMC-QC are as follows: (1) it is the largest and youngest private medical center offering PRM residency training in the country; and (2) its residents engage in telerehabilitation consultations for social service patients. A sample size computation is not deemed necessary for this study.

Data Collection Plan and Analysis

Letters to obtain permission to recruit participants will be sent to the department head of each of the two involved PRM residency training programs. Once approval is obtained, an e-mail containing the study details and informed consent form will be forwarded through the heads and chief residents. After the potential respondents have signed the consent form, data collection will commence.

There will be two phases of data collection. The first phase will only include the PRM residents as respondents to the online survey (**Supplementary Material 1**), which consists of the following items:

(1) Demographics: age, sex, highest level of experience with telerehabilitation prior to the pandemic, residency training institution, year level;
(2) Self-perceived attainment of PRM competencies through telerehabilitation; and
(3) Self-perceived learning of PRM topics and skills through telerehabilitation.

The original Likert-scale items for the self-evaluation of competencies and learning contents are based on the review of related literature and documents from the International Society of Physical and Rehabilitation Medicine (ISPRM) and the Philippine Board of Rehabilitation Medicine (PBRM). The questionnaire will undergo pretesting to ensure clarity of questions. The pretest will be conducted on 10 residents randomly recruited from PGH ($n = 8$) and SLMC-QC ($n = 2$). The residents' feedback on the wording, understandability, and applicability of the items will be considered in improving the questionnaire. The final version of the questionnaire will be available on Google Form™ in two separate parts to divide the length of the entire survey, and the links to each form will be distributed to the residents' personal email addresses and also coursed through their private social media groups (e.g., related to department concerns, or residents' group chat), if permitted by the department heads. The residents will be given 2 weeks to answer the 2 parts. The entire survey can be completed for <30 min during their most convenient time. Once a week, the residents will be reminded by the study authors through the help of the chief residents to accomplish the survey, if not yet done. Descriptive statistics (e.g., medians, frequencies, percentages) will be used to summarize the survey results and presented in data tables (**Supplementary Material 2**).

Aside from the demographic profile, the first part of the survey contains items on the residents' self-perceived attainment of PRM competencies, grouped into the following domains: patient safety and quality patient care; medical knowledge and procedural skills; interpersonal and communication skills; practice- and systems-based learning and improvement; reintegration of people with disabilities into the society; medical ethics and public health; quality assurance; policies of care and prevention for disabled people; and professionalism (11). Each item regardless of domain can be answered by a Likert scale as follows: [4] Strongly Agree; [3] Agree; [2] Disagree; [1] Strongly Disagree; or [0] Not applicable. Each item and domain will be summarized by counting the number of per-item and summed per-domain responses corresponding to each option in the scale. Meanwhile, the second part of the survey contains items on the residents' self-evaluation of learning of PRM topics and skills based on the recommendations of the ISPRM Education Committee (11). Each item is answerable by the following Likert scale: [3] Demonstrated—able to perform skills without supervision; or able to apply theoretical knowledge in PRM practice; [2] Practiced—able to perform skills, but needs supervision; or needs guidance to apply theoretical knowledge in PRM practice; [1] Introduced—able to recognize the principles and processes of PRM skills; or able to discuss PRM theories and concepts; or [0] Not applicable. The frequencies and percentages will also be presented per item, and a subtotal per main topic will present the sum of responses per option.

The second phase of data collection will include the department head, training officer, and chief resident of the 2 institutions ($n = 6$). They will be invited to one FGD through Zoom™. The projected duration of the FGD will be 2–3 h. If the discussion will extend longer than expected, the participants can choose to stay or withdraw at any time and for any reason, but their inputs during the discussion will still be considered in the analysis with their permission. Two study authors will facilitate the FGD. For a smooth conduct of the FGD, a set of predetermined guide questions will be used based on the quantitative results of the survey (e.g., "how can we explain the

findings of the survey?," "why do we think the residents felt that [a certain competency] was most or least achievable through telerehabilitation?," "which PRM competencies and topics can be adequately taught through telerehabilitation?"), review of the related literature, and anecdotal experiences of the residents and faculty from the study institutions. All the other study co-authors will be present during the FGD to support and balance the different points of view. The teleconference will be recorded solely for data transcription, as indicated in the informed consent form. Three study authors (CDL, FBC, and IES) will review the transcribed data to ensure quality and veracity, and perform thematic analysis. Their subjectivity will be acknowledged from the start of the analysis "to avoid affecting the integrity of the qualitative analysis trajectory" (8). The NVivo software version 12 plus (QSR International Pty Ltd., VIC, Australia) will be used to code the data and categorize relevant text fragments into themes (**Supplementary Material 3**).

Afterwards, findings from the quantitative and qualitative phases of data collection will be analyzed by the study authors through mapping of data onto each other and carefully reflecting upon them. Employing mixed methods integration, an iterative joint display (i.e., meta matrix) analysis process will be used to generate meta inferences (8). Finally, the study authors will compare and contrast findings from the quantitative and qualitative data analyses to develop a meaningful narrative and set of recommendations on possible curricular revisions to incorporate telerehabilitation in PRM residency training. The final thematic analysis of the FGD and recommendations will be forwarded to the FGD participants for review and approval. The flow of data collection and analysis is summarized in **Figure 1**.

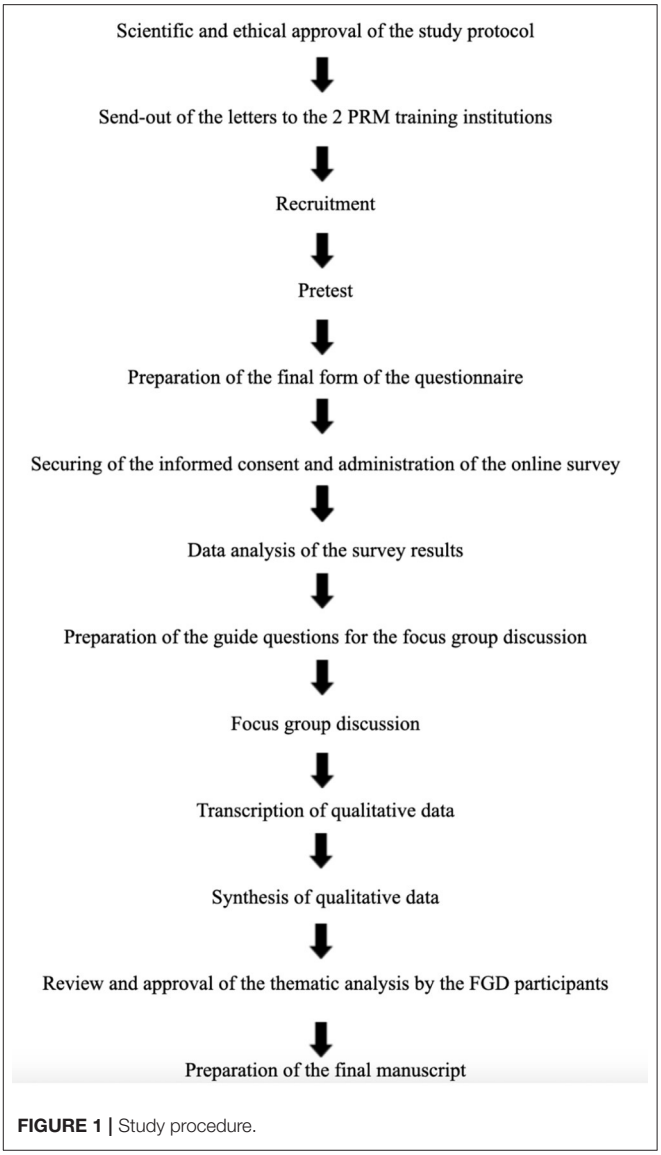

FIGURE 1 | Study procedure.

ETHICAL CONSIDERATIONS

The following guidelines will be used in developing the completed paper: (1) Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for reporting of quantitative data; and (2) Standards for Reporting Qualitative Research for reporting of qualitative data. The study protocol will undergo review by the University of the Philippines Manila—Research Ethics Board (UPM-REB) at PGH and the scientific and ethical committees of the Research and Biotechnology Group of SLMC-QC.

All quantitative data to be collected from the survey will remain anonymous through unique identifiers (i.e., participant code number), while data from the FGD will be transcribed with pseudonyms to be given discretely by each participant, whose real name, position and institution will remain undisclosed throughout the data analysis and manuscript writing. There is no foreseeable risk associated with the study participation, while its benefits are manifold as follows: (1) contribution to the development of improvement strategies for residency training; (2) opening the platforms for discussion of unexpressed feelings toward the current residency training program; and (3) provision of concrete recommendations to potentially incorporate a formal telerehabilitation curriculum into PRM residency in the Philippines, if deemed necessary based on the results of the study. There will be no vulnerable subjects and minors involved in the study.

No form of remuneration will be given to the survey and FGD participants. The envisioned long-term benefit that the study can contribute to the community will be the quality improvement of telerehabilitation services and PRM residency training in the country. The study aims and methods are not foreseen to cause any negative effect on the community.

The results of the study will be shared with the 2 involved training institutions and the Philippine Board of Rehabilitation Medicine. The completed study will be presented in local and international scientific conferences for sharing or exchange of experiences, and submitted to an international reputable journal in PRM.

DISCUSSION

This pilot study will provide baseline information on the PRM residents' ability to achieve core competencies through telerehabilitation. It is hypothesized that the majority of the residents are familiar with telerehabilitation and its technical know-how, but may have limited skills and experience in using it for virtual care. Suddenly telerehabilitation was used for patient encounters during the pandemic. Hence, it is uncertain whether telerehabilitation as a teaching-learning tool can help PRM residents achieve competencies in the different domains of training identified by the ISPRM, which is the internationally recognized society of the specialty.

Possible variations in the responses of the residents may be observed in the survey results based on their training institution, year level, and telerehabilitation experience pre-pandemic. In the future, the results of this pilot study can be used to come up with a larger study that involves all the other PRM training institutions in the Philippines. Nonetheless, it may be surmised that the residents may be able to improve their interpersonal and communication skills, medical knowledge, and even procedural skills through virtual patient encounters and didactics, as these are among the competencies expected in a telemedicine curriculum (12). In addition, through virtual care the residents may also be able to attain competencies in the other domains, such as patient safety and quality patient care, practice- and systems-based learning and improvement, reintegration of people with disabilities into the society, medical ethics and public health, quality assurance, policies of care and prevention for disabled people, and professionalism.

The residents' knowledge on the core topics recommended by the ISPRM, which is followed by the local PBRM, can be enhanced through telerehabilitation, although the skills-based competencies may have to supplemented with hands-on training and repeated and supervised in-person patient encounters. In a study by Chiu et al. the majority of the residents reported to have lesser clinical experience and lesser interaction with and supervision from attending physicians during telemedicine compared to in-person consultations (13). Meanwhile, practicing physiatrists in the Philippines expressed concerns about the lack of thorough patient examination through telerehabilitation (2).

The results of this study can catalyze the next steps toward curricular improvements in PRM residency training. Specifically, knowing which aspects of the pre-pandemic curriculum can be taught through telerehabilitation can guide PRM educators and administrators in optimizing telerehabilitation as a teaching-learning method for residency training, augmenting traditional in-person mode of instruction. Curricular improvements can also consider the inclusion of PRM competencies specific to telemedicine, such as standard virtual communication, webside manners, remote physical examination techniques, utilization of various telemedicine technology platforms, and skills in documenting virtual encounters (12). These competencies may equip the modern generations of PRM graduates for a more competent and professional conduct of telerehabilitation, which can be leveraged especially during national or international crises disrupting in-person delivery of rehabilitation services and clinical training.

ETHICS STATEMENT

The authors confirm that the manuscript has neither been previously published nor currently being considered for publication elsewhere. The manuscript reflects the authors' own research work. All sources used are properly cited. All authors have contributed substantially to the paper and will take public responsibility for its content.

AUTHOR CONTRIBUTIONS

CL conceptualized the research idea and wrote the protocol draft and revisions. FC, AT, and IS participated in the literature review and supplied details in different parts of the protocol. All authors contributed to the development of the research idea and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fresc.2022.921558/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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ORIGINAL RESEARCH
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Telerehabilitation Readiness, Knowledge, and Acceptance of Future Physiatrists in the Philippines: An Online Survey During the COVID-19 Pandemic

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Background: Clinical, educational, and research interest in telerehabilitation has not been widely explored until the COVID-19 pandemic. Amid the enduring pandemic, telerehabilitation remains part of the daily service, academic, and research responsibilities of residents in various training institutions worldwide.

Objective: To determine the Rehabilitation Medicine residents' current levels of telerehabilitation readiness, knowledge, and acceptance, their pattern of beliefs about telerehabilitation, and the factors affecting their readiness.

Methods: All bona fide residents from all training institutions in the Philippines were invited to participate in an online survey evaluating the following constructs: technological readiness (using the Technological Readiness Index or TRI 2.0); telerehabilitation knowledge (using an original multiple-choice examination); and telerehabilitation acceptance (using the Unified Theory of Acceptance and Use of Technology questionnaire). A pre-test and pilot test were conducted. The TRI responses were classified according to technology adoption segments to determine the respondents' pattern of beliefs about telerehabilitation.

Results: Sixty-two residents participated (86.1% response rate). They had good telerehabilitation readiness (3.3 ± 0.4 out of 5), fair telerehabilitation knowledge (2.1 ± 1.1 out of 5), and excellent telerehabilitation acceptance (4.5 ± 0.6 out of 5). The majority were classified either as telerehabilitation skeptics (38.7%), pioneers (19.4%), or explorers (19.4%). The factors that significantly influenced telerehabilitation readiness were optimism, innovativeness, discomfort, and insecurity ($p < 0.05$).

Conclusion: Despite having favorable levels of telerehabilitation readiness and acceptance, the Rehabilitation Medicine residents showed fair telerehabilitation knowledge. Our results suggest the need for formal education and training on virtual rehabilitation care during residency.

Keywords: telemedicine, telerehabilitation, remote rehabilitation, virtual rehabilitation, residency training, education, COVID-19, healthcare delivery

INTRODUCTION

Telerehabilitation, a branch of telemedicine, is an emerging method of delivering rehabilitation services through information and communications technology to connect patients and clinicians and minimize the barriers of distance, time, and cost (1). Specific telerehabilitation assessments and interventions using various computer- or gadget-based applications vary based on the patients' rehabilitation-related needs and resources and may include teleconsultations with specialists, teletherapy services (e.g., virtually facilitated exercise program, home instructions), and/or remote physiologic monitoring using body sensors technology (2).

With the rise of new technologies and "overcoming of the initial skepticism to which every new technology is subjected" (3), there has been an increase in the number of patients treated via telerehabilitation across the continuum of rehabilitation care and for various disabling conditions even before the pandemic (4). Catalyzed by the COVID-19 crisis, telerehabilitation is now being explored more widely to circumvent the persistent lack of in-person patient service in clinical, academic (undergraduate and postgraduate), and research settings especially in developing countries like the Philippines, which went through one of the longest lockdowns in the world (5–7). In the western region, a large descriptive retrospective study consisting of a sample of 222, 680 patients in the United States has considered synchronous video- or audio-based telerehabilitation as an alternative care model for different orthopedic and non-orthopedic cases during the pandemic (8). To this date, however, there is no internationally agreed telerehabilitation guideline possibly since different parts of the world may have various contexts, needs, and resources. In some countries in Southeast Asia, for instance, telerehabilitation guidelines were found to varying degrees of breadth and depth (9). Therefore, planning a telerehabilitation initiative may entail considerations of a multitude of human, organizational, and technical factors applicable to their respective setting (9, 10).

One way to prepare for a telerehabilitation program is to understand the readiness of potential target-users (i.e., patients, families, clinicians) for the technology (11). The uptake of telerehabilitation lies not solely in the hands of current Rehabilitation Medicine specialists, but those of the next generations as well. The current and future residents training for the specialty will eventually be the key persons or drivers of rehabilitation technologies. The residents who have been on the frontline during this pandemic are a rich source of first-hand experiences in the COVID-19 battlefield and may have a lot of ideas as to how rehabilitation care could be better delivered amid and beyond the pandemic. To our knowledge, the potential factors influencing this group of stakeholders' intentions to use telerehabilitation have not been explored. Evaluating and addressing the determinants of telerehabilitation readiness among different stakeholders can help administrators to develop more applicable and user-friendly telehealth-related programs, considering the former's technological capacity, knowledge, acceptance, preferences, and needs (2, 12).

Hence, the present study aimed to determine the Rehabilitation Medicine residents' baseline levels of telerehabilitation readiness, knowledge, and acceptance, their pattern of beliefs about telerehabilitation, and the factors affecting their readiness for telerehabilitation. The results of our study may serve as basis for program development or evaluation and capacity-building interventions related to improving telerehabilitation-related teaching and learning programs, research, and service delivery.

This study is founded on well-established concepts embedded in the Technology Readiness Index (TRI) version 2.0 questionnaire (13) and the Unified Theory of Acceptance and Use of Technology (UTAUT) model (14), wherein the outcome of interest is the actual intent to use a certain technology, which in this study is telerehabilitation. We define telerehabilitation readiness in this study as a resident's propensity to adopt and embrace this emerging technology for service, training, and research (6, 13). Based on the TRI questionnaire, technological readiness is affected positively by "motivators" (i.e., optimism and innovativeness) and negatively by "inhibitors" (i.e., discomfort and insecurity) (13). Meanwhile, telerehabilitation acceptance is the act of receiving and agreeing with the idea of using the technology to provide rehabilitation services over a distance (11). Adapted from the UTAUT model, the following factors may affect telerehabilitation acceptance: performance expectancy, effort expectancy, attitude, social influence, facilitating conditions, self-efficacy, anxiety, and behavioral intention (14, 15). Lastly, telerehabilitation knowledge pertains to the extent of information acquired by an individual through personal or vicarious experiences and any form of education or training related to the theoretical and practical understanding of the technology and its process.

METHODS

This was a cross-sectional study approved by the institutional research board and the Philippine Board of Rehabilitation Medicine (PBRM). We employed total enumeration of all bona fide residents across all year levels (i.e., 1st-3rd year and chief residents) training in all of the six Rehabilitation Medicine residency programs in the Philippines during the period of data collection (September to November 2020). Based on the census of residents (i.e., total number: 72) recognized by the PBRM, the sample size was computed at 62 with 0.05 margin of error. The eligibility criteria included access to stable Wi-Fi broadband and ability to provide full voluntary informed consent.

The entire survey could be accomplished within 10–20 min on Google Form™. The initial part collected the following demographic data: age, sex, residency training institution, year level in training, and prior telemedicine/telerehabilitation experience. The survey consisted of three questionnaires, namely: (1) the 16-item TRI version 2.0 to evaluate technology readiness; (2) an original 5-item multiple-choice test to evaluate telerehabilitation knowledge; and (3) the 31-item UTAUT questionnaire to evaluate telerehabilitation acceptance.

The validity and reliability of the survey were established through a pre-test. In addition, a pilot test involving 12 residents randomly selected from different training institutions was conducted prior to data collection to obtain feedback on how the wording of the survey and study implementation could be improved. During the actual data collection, respondents were given up to 3 months to complete the survey at their most convenient time. All data gathered remained anonymous and confidential. Descriptive (e.g., measures of central tendency, frequencies, and percentages) and inferential statistics (e.g., linear regression) were used to analyze the results with 95% confidence interval.

Telerehabilitation Readiness

The modified version of the TRI, also known as the Abbreviated Technology Readiness Index by Parasuraman and Colby, is a valid and reliable tool (Cronbach's alpha = 0.81) that measures overall technological readiness (13). Permission to use the tool was secured from the TRI developers (Rockbridge Associates, Inc.). Reliability testing of the questionnaire that we modified for our intended population was conducted through a pre-test of 12 randomly selected residents training in the study institution. The 16-item questionnaire, which evaluated the "motivators" and "inhibitors" affecting one's technological readiness, was answerable using a 6-point Likert scale per item as follows: strongly agree = 6; somewhat agree = 5; neutral = 4; somewhat disagree = 3; strongly disagree = 2; or not sure = 1. Each item corresponded to one of four technology readiness (TR) dimensions grouped as follows: (1) positive themes: optimism and innovativeness; and (2) negative themes: insecurity and discomfort. There were 4 items that examined each dimension, and an average score for each dimension was computed per respondent. The total TR score was computed per respondent using the following formula: TR = (Optimism + Innovativeness + [6-Insecurity] + [6-Discomfort]) / 4 (13, 15). The total scores were directly proportional to technological readiness and interpreted as follows: 1.00−1.80 = poor, 1.81−2.60 = fair, 2.61−3.40 = good, 3.41−4.20 = very good, 4.21−5.00 = excellent telerehabilitation readiness. Based on the anonymized responses, the TRI developers grouped each respondent into one of the following categories in the order of decreasing likelihood of technology adoption: explorers, pioneers, skeptics, hesitators, and avoiders (13, 15).

Telerehabilitation Knowledge

Three professors in the study institution, who are considered early adopters of the technology and have delivered local and international talks on telerehabilitation, convened to come up with 5 original multiple-choice questions to evaluate the residents' basic telerehabilitation knowledge. They considered the questions as must-knows in providing a quality telerehabilitation service. The questions were subjected to a pre-test and modified accordingly to achieve an acceptable Cronbach's alpha of at least 0.70. To ensure understandability of the questions, a pilot test was also done. Each correct answer was given 1 point, and the sum of scores was computed for each respondent and interpreted as follows: 1.00−1.80 = poor, 1.81−2.60 = fair, 2.61−3.40 = good, 3.41−4.20 = very good, 4.21−5.00 = excellent telerehabilitation knowledge.

TABLE 1 | Demographic profile of the respondents ($N = 62$).

Characteristics	*n* (%) or Mean ± SD
Sex	
Female	33 (53.2)
Male	29 (46.8)
Age, years	30.3 ± 2.7
Residency training institution	
Philippine General Hospital	20 (32.3)
Philippine Orthopedic Center	17 (27.4)
University of Santo Tomas	9 (14.5)
Ospital ng Makati	7 (11.3)
Veterans Memorial Medical Center	5 (8.1)
St. Luke's Medical Center	4 (6.5)
Year level	
1st	23 (37.1)
2nd	18 (29.0)
3rd	17 (27.4)
Chief residency (if extra year)	4 (6.5)
With prior telerehabilitation experience	33 (53.2)

Telerehabilitation Acceptance

Telerehabilitation acceptance was evaluated using the validated 31-item UTAUT questionnaire, which consists of the following constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), attitude (AT), anxiety (AX), self-efficacy (SE), and behavioral intention (BI) to use the technology (16–18). Each item consisted of Likert scale responses as follows: strongly agree = 6; somewhat agree = 5; neutral = 4; somewhat disagree = 3; strongly disagree = 2; and not sure = 1. Reliability testing of the questionnaire to suit the present study's target population was conducted following the same method previously described for telerehabilitation readiness. Three or more items evaluated one particular construct. The means and standard deviations were used to summarize the data per item and per construct. The overall mean of the constructs per respondent was interpreted as follows: 1.00−1.80 = poor, 1.81−2.60 = fair, 2.61−3.40 = good, 3.41−4.20 = very good, 4.21−5.00 = excellent telerehabilitation acceptance.

Lastly, to determine the factors that influenced the respondents' readiness for telerehabilitation, the mean TRI scores were used. Since data indicating telerehabilitation readiness were in ratio-continuous form, linear regression was done. Tests of assumption (e.g., linearity, normality, heteroscedasticity, multicollinearity) were performed beforehand to ensure that the regression model test statistics were applicable. Wherever data were not suitable for such tests, non-parametric test statistics were conducted.

TABLE 2 | Telerehabilitation readiness of the respondents ($N = 62$) based on the modified Technological Readiness Index (TRI) version 2.0*.

Items per TRI dimension	Mean ± SD†
Optimism	
Telerehabilitation can contribute to a better quality of life.	5.4 ± 0.6
Telerehabilitation can provide users with more freedom of mobility.	5.1 ± 0.8
Telerehabilitation can give users more control over their daily lives.	4.7 ± 1.0
Telerehabilitation can make me more productive in my personal life.	4.7 ± 0.8
Average score for optimism	**5.0 ± 0.6**
Innovativeness	
Other people come to me for advice on new technologies.	4.5 ± 1.2
In general, I am among the first in my circle of friends to acquire new technology when it appears.	3.6 ± 1.1
I can usually figure out new high-tech products and services without help from others.	4.4 ± 1.1
I keep up with the latest technological developments in my areas of interest.	4.6 ± 1.1
Average score for innovativeness	**4.3 ± 0.8**
Discomfort	
When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.	3.3 ± 1.1
Technical support lines are not helpful because they don't explain things in terms I understand.	3.4 ± 0.8
Sometimes, I think that technology systems are not designed for use by ordinary people.	3.9 ± 1.1
There is no such thing as a manual for a high-tech product or service that's written in plain language.	3.6 ± 1.1
Average score for discomfort	**3.6 ± 0.7**
Insecurity	
People are too dependent on technology to do things for them.	4.5 ± 1.0
Too much technology distracts people to a point that is harmful.	4.9 ± 1.0
Technology lowers the quality of relationships by reducing personal interaction.	4.7 ± 1.0
I do not feel confident interacting with someone that can only be reached online.	4.0 ± 1.1
Average score for insecurity	**4.5 ± 0.7**
Mean TRI Score‡ (telerehabilitation readiness)	**3.3 ± 0.4**

Cronbach's alpha >0.70. †Responses ranged from 1 to 6 as follows: strongly agree = 6; somewhat agree = 5; neutral = 4; somewhat disagree = 3; strongly disagree = 2; or not sure = 1. ‡TRI score per respondent was computed using the following formula: TRI = (Optimism + Innovativeness + [6-Insecurity] + [6-Discomfort]) / 4. Values in boldface represent average scores per dimension and overall TRI.

TABLE 3 | Tally of responses on the multiple-choice questions regarding telerehabilitation ($N = 62$).

Telerehabilitation knowledge questions and choices	Responses, *n* (%)
1. What is the recommended megapixel requirement of the web camera for optimal videoconferencing?	
a. 1–3	2 (3.2)
b. 3–5	15 (24.2)
c. 5–8*	**25 (40.3)**
d. >8	20 (32.3)
2. Which of the following is NOT included in the Principles of Informed Consent?	
a. Patient needs to be given the information.	4 (6.5)
b. Patient needs to understand the information.	0 (0.0)
c. Patient needs to make a choice.	21 (33.9)
d. Patient has to affix his/her signature above printed name to signify consent*.	**37 (59.7)**
3. Which simulation role is being described in the following statement? An individual with background in the health sciences; must be available at the originating site to present the patient, manage the cameras, and perform any hands-on activities; may sometimes provide information about the patient to the provider that the provider could not otherwise obtain.	
a. Clinic manager	21 (33.9)
b. Technical support	10 (16.1)
c. Telepresenter*	**28 (45.2)**
d. Receptionist/ scheduler	3 (4.8)
4. Which of the following is NOT included in the 3 main levels of risk-mitigation to ensure cyber-security?	
a. People who can access the system	6 (9.7)
b. Internet connectivity*	**29 (46.8)**
c. Technical components	14 (22.6)
d. The information itself	13 (21.0)
5. What is the recommended Internet bandwidth for a single healthcare provider practice?	
a. 8 megabits per second (Mbps)	**25 (40.3)**
b. 6 Mbps	23 (37.1)
c. 2 Mbps*	9 (14.5)
d. None of the above	5 (8.1)

Correct answers. Values in boldface represent the most common response per item.

RESULTS

A total of 62 out of 72 residents participated (86.1% response rate). The demographic characteristics of the respondents are presented in **Table 1**. Of special note, more than 50% had telerehabilitation experience prior to the survey.

The overall TRI score of the respondents was 3.3 ± 0.4 out of 5, interpreted as good telerehabilitation readiness. The TR dimension with the highest mean score was optimism, while the one with the lowest score was discomfort (**Table 2**). Based on the TRI responses, the majority were classified as telerehabilitation skeptics ($n = 24$, 38.7%), followed by pioneers ($n = 12$, 19.4%), explorers ($n = 12$, 19.4%), hesitators ($n = 11$, 17.7%), and avoiders ($n = 3$, 4.8%).

The respondents had a mean telerehabilitation knowledge score of 2.1 ± 1.1 out of 5, interpreted as fair. Each item was correctly answered by <50% of the respondents, except for item number 2 in which almost 60% correctly identified the principles of informed consent (**Table 3**). On the other hand, <15% got the correct answer for the item regarding the minimum Internet bandwidth recommendation for a single healthcare provider practice.

TABLE 4 | Telerehabilitation acceptance of the respondents ($N = 62$) based on the modified Unified Theory of Acceptance and Use of Technology (UTAUT) questionnaire*.

Items per UTAUT construct	Mean ± SD†
Performance expectancy: the degree to which the respondent believes that telerehabilitation can help physiatrist and patient attain gains in healthcare	
I find telerehabilitation useful in my job.	4.9 ± 1.2
Using telerehabilitation enables me to accomplish tasks more quickly.	4.3 ± 1.4
Using telerehabilitation increases my productivity.	4.3 ± 1.3
If I use telerehabilitation, I will increase my chances of earning more in the future.	4.1 ± 1.4
Average score for performance expectancy	**4.4 ± 1.2**
Effort expectancy: the degree to which the respondent believes that ease is associated with use of telerehabilitation	
My interaction with telerehabilitation could be clear and understandable.	4.4 ± 1.2
It could be easy for me to become skillful at using telerehabilitation.	4.4 ± 1.1
I find telerehabilitation easy to use.	4.2 ± 1.1
Learning to operate telerehabilitation is easy for me.	4.5 ± 1.1
Average score for effort expectancy	**4.4 ± 1.0**
Attitude: the degree to which the respondent believes that using telerehabilitation is a good idea	
Using telerehabilitation is a good idea.	4.7 ± 1.0
Telerehabilitation makes work more interesting.	4.2 ± 1.2
Working with telerehabilitation is fun.	3.9 ± 1.2
I like working with telerehabilitation.	4.0 ± 1.3
Average score for attitude	**4.2 ± 1.0**
Social influence: the degree to which the respondent perceives that his/her colleagues or institution believe/s he/she needs to use telerehabilitation	
People who influence my behavior think that I should use telerehabilitation.	4.2 ± 1.2
People who are important to me think that I should use telerehabilitation.	4.2 ± 1.2
Our department has been helpful in the use of telerehabilitation.	4.7 ± 1.1
In general, our department has supported the use of telerehabilitation.	5.1 ± 1.1
Average score for social influence	**4.5 ± 0.9**
Facilitating conditions: the degree to which the respondent believes that an organization and infrastructure exist to support use of telerehabilitation	
I have the resources necessary to use telerehabilitation.	4.9 ± 1.1
I have the knowledge necessary to use telerehabilitation.	4.8 ± 1.0
Telerehabilitation is not compatible with other aspects of my work‡.	4.3 ± 1.2
A person or group inside or outside our department is available for assistance with telerehabilitation difficulties.	4.3 ± 1.3
Average score for facilitating conditions	**4.6 ± 0.8**
Self-efficacy: the degree of the respondent's judgement to use telerehabilitation	
I could complete a job or task using telerehabilitation even if there was no one around to tell me what to do.	4.6 ± 1.1
I could complete a job or task using telerehabilitation if I could call someone for help if I got stuck‡.	4.7 ± 0.9
I could complete a job or task using telerehabilitation if I had a lot of time‡.	4.8 ± 1.0
I could complete a job or task using telerehabilitation if I had the built-in help facility for assistance‡.	4.7 ± 1.2
Average score for self-efficacy	**4.7 ± 0.8**
Anxiety: the degree to which the respondent hesitates to use telerehabilitation	
I feel apprehensive about using telerehabilitation‡.	4.0 ± 1.1
It scares me to think that I could lose a lot of information using telerehabilitation‡.	4.7 ± 1.2
I hesitate to use telerehabilitation for fear of making mistakes I cannot correct‡.	4.2 ± 1.3
Telerehabilitation is somewhat intimidating to me‡.	3.6 ± 1.1
Average score for anxiety	**4.1 ± 0.9**
Behavioral intention: the degree to which the respondent intends to use telerehabilitation	
I intend to use telerehabilitation in the next 6 months.	4.7 ± 1.2
I predict I would use telerehabilitation in the next 6 months.	5.1 ± 0.9
I plan to use telerehabilitation in the next 6 months.	4.9 ± 1.0
Average score for behavioral intention	**4.9 ± 0.9**
Mean UTAUT Score (Telerehabilitation Acceptance)	**4.5 ± 0.6**

**Cronbach's alpha >0.70. †Responses ranged from 1 to 6 as follows: strongly agree = 6; somewhat agree = 5; neutral = 4; somewhat disagree = 3; strongly disagree = 2; or not sure = 1. ‡Scored reversely. Values in boldface represent average scores per construct and overall UTAUT.*

The overall UTAUT score of the respondents was 4.5 ± 0.6 out of 5, interpreted as excellent telerehabilitation acceptance. The UTAUT constructs with the highest mean scores were: (1) behavioral intention (4.9 ± 0.9); (2) self-efficacy (4.7 ± 0.8); and (3) facilitating conditions (4.6 ± 0.8) (**Table 4**).

Based on linear regression, the following factors showed significant associations with telerehabilitation readiness: optimism, innovativeness, discomfort, and insecurity [F (9.612, 0.05) = 0.000, $p < 0.05$], with an R^2 of 1.000. On the other hand, the rest of the variables (i.e., telerehabilitation knowledge, performance expectancy, effort expectancy, attitude, social influence, facilitating conditions, self-efficacy, anxiety, and behavioral intention) did not reach statistical significance ($p > 0.05$).

DISCUSSION

Our study showed that the Rehabilitation Medicine residents in the Philippines have good telerehabilitation readiness, fair telerehabilitation knowledge, and excellent telerehabilitation acceptance. Although the majority were classified as telerehabilitation skeptics (38.7%), combining telerehabilitation explorers (19.4%) and pioneers (19.4%), the two highest levels of technology adopters, comprised an almost equal percentage (38.8%). The factors that significantly influenced telerehabilitation readiness were the respondents' optimism, innovativeness, discomfort, and

insecurity ($p < 0.05$), while telerehabilitation knowledge and UTAUT scores were not found to be statistically associated with readiness.

Our data was collected after more than 6 months into the pandemic. By then, the impact of the unprecedented COVID-19 crisis had become evident, particularly altering the way training, service, and research were conducted in the six Rehabilitation Medicine residency training programs, which are all located in Manila, the epicenter of the pandemic in the Philippines. It is not difficult to surmise that the residents, who are relatively young (∼30 years of age), would have adapted to the sudden shift to virtual care and training, evidenced by their favorable telerehabilitation readiness and acceptance. However, their theoretical knowledge of telerehabilitation neither seemed adequate nor congruent with their readiness and acceptance.

It is established that many factors like knowledge, skills, attitude, and working environment contribute to the success of any new technology or its adoption (19). Telerehabilitation was neither widely taught nor practiced in the Philippines before the pandemic. As COVID-19 continues to cause a significant decline in the number of patients able and willing to access in-person rehabilitation, there is a need to strengthen the awareness, feasibility, and potential role of telerehabilitation among its stakeholders (5, 6). It is, therefore, important to establish a strong foundation of telerehabilitation principles among its target users, particularly the current and future clinicians who are considered the primary drivers of this emerging technology (10).

Traditionally, telehealth or telemedicine, let alone telerehabilitation, was not included in the curriculum of most, if not all, premedical, medical, and/or residency training programs in the Philippines (5, 20). In contrast, universities abroad mostly in developed countries like Australia, France, United Kingdom, and United States of America have had telehealth and/or telerehabilitation courses even before the pandemic (21, 22). Hence, an instructional design on telerehabilitation could possibly gain inspiration and guidance from existing formats from reputable institutions that have had wide experience in teaching telerehabilitation to students or professionals. Nonetheless, the curriculum design has to be adapted and contextualized according to the needs and resources in the local setting (5, 23, 24). Given that most, if not all, the current Rehabilitation Medicine residents have comparable levels of technological proficiency, the content of telerehabilitation training has to go beyond the basic and technical aspects and include ethical, legal, and socioeconomic principles applicable in their target area of practice (25).

Our study showed that almost half of the respondents did not have any telerehabilitation experience at the time of data collection. With the intermittent suspensions of outpatient rehabilitation services in Metro Manila and the prevailing apprehension of patients about in-person consultations and therapy sessions because of the unpredictable COVID-19 situation, the Rehabilitation Medicine residents encounter a significant decline of cases and, therefore, learning opportunities (6). Hence, telerehabilitation could be leveraged to augment their lack of clinical exposure (6). However, faculty and residents alike will need to adapt and relearn the conduct of routine physiatric history-taking and evaluation in the context of remote interaction. Acknowledging the inherent limitations of virtual physical examination, and ensuring benefits outweigh potential risks, the clinical principles of evaluating and managing various disabilities through telerehabilitation may have to be included in the curricular modifications of residency training in Rehabilitation Medicine.

Research interest in telerehabilitation has not been widely explored around the world until recently (11). Considered an emerging technology in the field of rehabilitation, telerehabilitation has yet to be given a globally agreed definition, scope, and standard practice among others. In the Philippines, as telerehabilitation continues to be a huge part of the daily service and training duties of residents in some institutions amid the enduring pandemic, it would be useful to develop a set of core competencies and evaluation methods to ensure that the standard practice of Rehabilitation Medicine is upheld in every virtual encounter. It would be a disservice to the patients if telerehabilitation were not conducted competently, ethically, and conscientiously.

Our study focused only on the current Rehabilitation Medicine residents. However, there are many other stakeholders that have to be evaluated as well, such as the patients and primary caregivers, consultant physiatrists, administrative staff, therapists, nurses, rural clinicians, and medical students. They could be potential targets of future research in order to determine their telerehabilitation perceptions. Exploratory qualitative studies about factors that could affect their telerehabilitation readiness, knowledge, and acceptance are recommended. Nonetheless to our knowledge, our study was the first in local and international literature to provide baseline data on the perceptions of physiatrists in-training regarding telerehabilitation. The design of our study and data may serve as benchmark for potential research on telerehabilitation education and training in the future.

CONCLUSION

The Rehabilitation Medicine residents in the Philippines had mixed levels of telerehabilitation adoption, which ranged from being skeptics to pioneers and explorers. Although it seemed that despite their relatively low telerehabilitation knowledge and high telerehabilitation acceptance, their optimism and innovativeness seemed to be significant facilitators of telerehabilitation readiness. A call to action is warranted for incorporating telerehabilitation in the curriculum of Rehabilitation Medicine residency training to ensure quality of virtual care.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

This study was reviewed and approved by the University of the Philippines Manila-Research Ethics Board (UPM-REB). The participants provided their voluntary informed consent to participate in the study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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POLICY AND PRACTICE REVIEWS
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Common Bias and Challenges in Physical and Rehabilitation Medicine Research: How to Tackle Them

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The importance of evidence-based medicine is crucial, especially in physical and rehabilitation medicine (PRM), where there is a need to conduct rigorous experimental protocols, as in any medical field. Currently, in clinical practice, therapeutic approaches are often based on empirical data rather than evidence-based medicine. However, the field of PRM faces several challenges that may complicate scientific research. In addition, there is often a lack of appropriate research training in educational programs. In this context, we aim to review the methodological challenges in PRM and provide clear examples for each of them as well as potential solutions when possible. This article will cover the following themes: (1) Choosing the right study design and conducting randomized and benchmarking controlled trials; (2). Selecting the appropriate controlled, placebo or sham condition and the issue of blinding in non-pharmacological trials; (3) The impact of populations' heterogeneity and multi-comorbidities; (4). The challenge of recruitment and adherence; (5). The importance of homogeneity and proper quantification of rehabilitative strategies; and (6). Ethical issues. We are convinced that teaching the basics of scientific research in PRM could help physicians and therapists to choose a treatment based on (novel) scientific evidence. It may also promote scientific research in PRM to develop novel and personalized rehabilitation strategies using rigorous methodologies and randomized or benchmarking controlled trials in order to improve patients' management.

Keywords: clinical trial, evidence-based medicine (EBM), treatment, traumatology, study design

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INTRODUCTION

Most of the current research in physical and rehabilitation medicine (PRM) is built on applied research, which by definition is research that uses existing knowledge to achieve specific goals; they are designed to solve a specific problem affecting a specific individual or a group of patients. The field of research in PRM is highly translational (1), meaning that the aim is to transfer data obtained from scientific research (e.g., in laboratories) into clinical setting results (e.g., in rehabilitation), commonly referred to as the "Bench to Bedside" approach. However, conducting translational research is extremely complex as it encompasses many biases and risks that must be considered in order to provide robust results that can be replicated and recognized as newly validated rehabilitation strategies. Indeed, even if a lot of progress has been made to implement evidence based medicine in clinical practice, this transition should be further accelerated (2).

As any medical fields, the development and progress of novel and optimized interventions in PRM depends on their validation in well-designed research protocols. However, due to several factors (e.g., concomitant therapies, blinding difficulties, proper controlled condition, patients' heterogeneity), the implementation of double-blind randomized placebo controlled trials (i.e., the gold standard in evidence based medicine), can be extremely complicated depending on the intervention studied. Indeed, rehabilitation, in most cases, encompasses very heterogeneous inter and intra-individual approaches, which is in contradiction with the homogeneity and standardization of interventions required in research protocols. In addition, as compared to strict research protocols, where the goal is to control the patient's external environment, the final objective of research in PRM is to enhance the effectiveness of an intervention in real world circumstances (3, 4). In this context, the notion of real-effectiveness medicine (REM) has been introduced by Malmivaara and proposes a certain balance between the necessary robustness of research protocols and the real-life constraints of PRM (3). REM recommends to act on different levels as follows: (1) benchmarking (i.e., learning from the peers); (2) quality (i.e., real world performance); (3) evidence-based medicine (EBM; i.e., up-to-date scientific evidence) and (4) competence (i.e., basis for effectiveness, efficacy and equity). This framework has been proposed to provide the best cares for patients in real-world settings (as opposed to research settings).

In parallel with this, recently, the Cochrane Rehabilitation experts consortium have proposed the following definition for rehabilitation in the context of research: "*In a health care context*, rehabilitation is defined as a "*multimodal, person-centered, collaborative process*" (**Intervention-general**) including interventions targeting a person's "*capacity (by addressing body structures, functions, and activities/participation) and/or contextual factors related to performance*" (**Intervention-specific**) with the goal of "*optimizing*" the "*functioning*" (**outcome**) of "*persons with health conditions currently experiencing disability or likely to experience disability, or persons with disability*" (**Population**) (5). As stated by the authors, this definition has the advantage of providing explicit inclusion and exclusion criteria; could impact future research production; is a first edition, thus may be revised in the future (5).

As more and more (Ph.D) students and clinicians in PRM are involved in research, it is critical to provide them with the appropriate tools to successfully and efficiently carry out research projects. In this context, this article aims to discuss critical aspects to take into account when testing the effect of an intervention in the context of PRM, in order to promote robust research in this field and enhance the clinical translation of evidence based practice.

SELECTING THE APPROPRIATE STUDY DESIGN

Scientific research should always begin with the development of a research question. For each research question, it is important to identify the appropriate research design that could answer it. In general, there are three main study designs: *descriptive*, *exploratory* and *experimental*. A descriptive design will be used when the objective is simply to describe a particular population (e.g., describe the intensity of pain or the mobility capacities of a population suffering from low back pain); an exploratory/analytic design will be used when the objective is to describe a relationship between two variables (e.g., investigate the relationship between lower limb amputation and quality of life or investigate if age can be a predictive factor of the recovery of lower back pain); an experimental design will be used when the objective of the study is to investigate the effect of a rehabilitation protocol on a particular population (e.g., efficacy of hippotherapy vs. usual care on motor capacities of patients suffering from multiple sclerosis - MS).

Epidemiological studies using descriptive or exploratory designs are classified as "observational studies" or "non-experimental studies". No intervention is used, and no attempt to alter the course of the disease is made. Different observational studies exist as exposed in **Table 1.**

Studies using an *experimental design* are classified as "*experimental studies*". In a clinical trial, study participants are usually divided into two groups; one group receives an intervention and the other group does not. An outcome of interest is then compared between these groups and estimates the impact of the intervention. The clinical trials may be classified into different types (12, 13), namely, parallel, crossover and factorial designs (see **Table 2**), depending on the objective of the study and the population studied.

In addition, clinical trials may also be categorized according to their purpose. We can differentiate *superiority trials*, *equivalence trials* and *non-inferiority trials* (12).

Even though all study designs can be used in PRM, they do not have the same level of evidence. The evidence-based medicine pyramid can be used to rank these studies according to their level of evidence. Studies at the top of the pyramid are studies with a higher level while studies at the bottom of the pyramid are studies with a lower level of evidence. The main reason is that the higher we go in the pyramid of evidence, the lower risk of methodological bias there is.

TABLE 1 | Different observational study designs.

Cross-sectional studies – *descriptive design* (6, 7)
A cross sectional study involves looking at data from a population at one specific time point. It can be considered as a snapshot of a particular population at a particular point of time. These studies are often used to look at the prevalence of some characteristics in a given population (e.g., prevalence of depression in a population of patients suffering from MS). This type of study can be used to "describe" characteristics that exist in a population but not to determine cause-effect relationship between variables (e.g., it cannot determine if MS leads to higher depression symptoms). Cross-sectional studies can be used to gather preliminary data to support further research.
Case-control studies – *exploratory design* (8, 9)
A case-control study compares patients with a certain disease (or an outcome of interest), i.e., the "cases", with patients who do not have the disease, i.e., the "controls" and looks at how frequently both groups have been exposed to a risk factor. If more participants in the case group experienced the risk factor, this suggests that it is likely that there is a link between the risk factor and the disease. These studies are usually retrospective, appropriate for studying rare conditions or rare diseases, often easy to implement and do not require a lot of time and they give the opportunity to simultaneously look at multiple risk factors. However, they are often confronted with low data quality because they rely on retrospective data, and sometimes, recall bias. Recall bias in a case-control study is the increased likelihood that those with the outcome (e.g suffering from a disease) will recall more and report exposures (e.g. symptoms) compared to those without the outcome. This may lead to concluding that there are associations between the exposure and the disease that do not, in fact, exist. Moreover, due to their typically retrospective nature, case-control studies can be used to establish a correlation between exposures and outcomes but cannot establish causation. These studies simply attempt to find correlations between past events and the current status of a condition.
Cohort studies (prospective cohort studies or retrospective cohort studies) – *exploratory design* (10, 11)
A cohort study is a longitudinal study were participants, who usually share a common characteristic, are followed over a certain period of time to evaluate the occurrence of an outcome of interest. A correlation between the exposure to risk factors (that can be present or not at the beginning of the follow-up) and the development of a particular outcome is measured. (e.g., follow-up of patients suffering from spinal cord injury and evaluation of the occurrence of different outcomes such as hospitalization and mortality between different types of spinal cord injuries). Cohort studies are very important in epidemiology to understand which risk factors may increase or decrease the likelihood of developing an outcome or a disease. Cohort studies may be prospective or retrospective. In prospective cohort studies, when a population is included in the study, the potential exposure of interest is first measured. Then, the population is classified as having been exposed or not exposed to the risk factors and participants are followed prospectively over time. The investigators then assess the outcome of interest in these individuals. In retrospective cohort studies, data is collected from records; the outcomes have occurred in the past. Cohort studies are therefore robust and effective to establish cause and effects, which cannot be established with the previous study designs. A cohort study may be helpful to study multiple outcomes to the same exposure but also helpful to study the relationship between outcome and exposure, even if the exposure is rare. However, collecting prospective data from a large number of patients over many years is often challenging, time-consuming and expensive. For example, to study the incidence of cardiovascular events in patients suffering from Parkinson, researchers may have to follow the cohort for many years before the studied outcome occurs. Indeed, cohort studies may not be very efficient for rare outcomes (for which a case-control study may be preferred), except in some conditions.

In PRM, although placebo randomized controlled clinical trial are not always possible to implement because of different methodological problems (14) (**Table 3**), these studies remain the gold standard design. Many interventions may be non-pharmacological interventions (e.g., injections, rehabilitation protocols, noninvasive brain stimulation, aqua therapy, acupuncture, etc.) which reinforce the difficulties inherent to the implementation of such study design.

Because of the difficulties related to the implementation of randomized controlled trial (RCT) in PRM research, one-way design studies, called pre-posttest studies are sometimes conducted, as an alternative. In these studies, only one group of patients is included and receives an intervention. To show the effect of the intervention on a particular outcome, the independent variable is measured before and after the intervention. These studies are the weakest type of experimental design. A major limitation is the lack of a comparison group and the impossibility to measure truly the impact of the intervention, given the large amount of cofounding factors that may be present in PRM patients.

Another, alternative to placebo randomized controlled clinical trial are *pragmatic trial* (15). Pragmatic trials are designed to evaluate the effectiveness in real-life routine practice conditions and produces, therefore, results that can be applied in routine practice clinical settings. Contrarily to experimental designs such as placebo randomized controlled trials that aims to test whether an intervention works under optimal conditions (e.g., inclusion/exclusion criteria, standardized protocols regarding the intervention, etc.), pragmatic trials are conducted in real-world clinical practice settings, with typical patients and by qualified clinicians. In pragmatic trials, inclusion criteria are often less strict, randomization could be performed at the group level (e.g., one group of participants could be treated in a particular setting and a second group of participants, matched to be similar to the first group might serve as the control group) and a wide spectrum of outcomes, mostly patient-centered, could be considered. Because they better suit with research in PRM, pragmatic trials are becoming increasingly popular in this area of research. Besides, the notion of benchmarking controlled trial (BCT) (observational study) has been recently proposed as an alternative to RCT (experimental study) as it might be more suitable for translational research especially in the field of PRM (16). In addition, in another opinion paper, the author exposed the notion of clinical impact research and the necessity to conduct more BCTs as this study designs are closer to the real-world constrains in rehabilitation, advocating that the translation of the results from RCT are limited (17, 18). The term benchmarking is derived from the necessity to make between-peer comparisons, and thus learn from the best practices. In short, BCT aims at assessing the efficacy of one or multiple interventions or clinical pathways, in real-world settings, thus being observational. BCT might be preferred to

TABLE 2 | Different interventional study designs.

Parallel group design
Parallel group design is the most common form of clinical trials. In these trials, participants are divided into two (or more) groups, with one of the groups receiving the intervention and the other not (i.e., controlled condition – see section Selecting the Appropriate Study Design for more details).
Cross-over design
In a cross-over design, each patient receives both interventions but in a different, randomized, order. Half of the participants therefore start with treatment A and then switch to treatment B (AB sequence). The other half of the participants start with treatment B and then switch to treatment A (BA sequence). An adequate washout period should be considered in order to eliminate the effect of the previous intervention before starting the second one, to avoid a carry-over effect. In this case, each participant serves as his/her own control. This type of study therefore requires a smaller sample size, which is a significant advantage in PRM. It is important that the condition is chronic, relatively stable and does not get completely cured during the first part of the trial. One disadvantage of this study design is that the duration of follow-up for the patient is longer than the duration for a parallel group design, which increases the risk of dropout and increases the risk of leading to a compromised study power. In addition, cross-over designs are not suited to investigate multiple dose levels of an intervention.
Factorial design
In factorial design experimental studies, the investigators tests more than one intervention simultaneously (e.g., multimodal interventions such as a combination of dietary supplements and physical rehabilitation for the improvement of muscle strength in patients with transfemoral amputation). This study design is appropriate for the study of two or more interventions using various combinations. Often, 4 groups of participants are included; the first one receives both interventions, the second group receives the first intervention, the third group receives the second intervention, and the last group serves as control group. This study design is very helpful because both interventions may be tested at the same time. Moreover, sample size requirements are often lower. However, recruitment for these studies is challenging since participants should meet inclusion criteria, not only for one intervention but for two or more at the same time. Moreover, these studies also require an absence of interaction between interventions.
Superiority trials
In *superiority trials*, the purpose is to assess if one intervention is different compared with another intervention or with a placebo. The null hypothesis is that there is no difference between groups and the alternative hypothesis is that there is a difference between both interventions.
Equivalence trials
In *equivalence trials*, the purpose is to show that a new intervention is equivalent to another existing one. Certain advantages of the new intervention may explain researchers interest in it, such as better safety or higher cost-effectiveness. In these studies, the null hypothesis is that the difference between the new intervention and the standard intervention is greater than a certain predefined effect size and the alternative hypothesis is that the difference between the tested intervention and the standard intervention is not greater that this predefined effect size.
Non-inferiority trials
In *non-inferiority* trials, the purpose is to show that a new intervention is "not worse" compared to another existing intervention in terms of efficacy, but demonstrates, for example better safety issue. In such a trial, the null hypothesis is that the difference between the new intervention and the existing one is greater that a certain predefined effect size and the alternative hypothesis is that the difference between both intervention is lower than this predefined effect size.

RCT due to ethical considerations or feasibility reasons, as well as when it comes to the evaluation of the efficacy of a clinical pathway or performance of health care providers (17). Specific recommendations have been proposed to develop and evaluate the effectiveness of observational BCTs. In the future, more BCTs might be available in the literature [for more information on this topic see (16–19)].

One important aspect when it comes to conduct a study protocol, is the reporting guidelines. Such Guidelines have been developed to help researchers report all details of their study allowing for an appropriate understanding by readers, a proper replication of the study protocol, Its use by a clinician for a clinical decision as well as to be included in a meta-research study. In 2015, EQUATOR, created a flow chart to help authors identify the most appropriate guidelines based on their study design. The EQUATOR website (https://www.equator-network.org/reporting-guidelines/) provides a census of all the available reporting guidelines. In short, for observational studies, the STROBE checklist and extensions may be used and for clinical trials, the CONSORT checklist and extensions (e.g., extensions for cross-over trials, non-inferiority trials, etc.) may be used.

Recently, Cochrane Rehabilitation Methodology Meetings have been organized with the aim to improve the methodology used in PMR to generate effective and translational evidence (20). In this context, the RCT Rehabilitation Checklists (RCTRACK) project have been proposed to develop specific guidelines specific for research conducted in rehabilitation (20), whose work is ongoing.

CHOOSING A PROPER CONTROLLED CONDITION AND BLINDING STRATEGIES

As described in the previous section, RCTs are the gold standard to test the efficacy of a novel treatment. Nevertheless, compared to pharmacological RCTs, finding an appropriate controlled condition (i.e., placebo) might be extremely challenging in the context of PRM, which makes the design of RCTs complex. Placebo controlled double-blind trials are however crucial to validate the efficacy of a treatment as uncontrolled and open-label trials suffer from important risk of biases that can alter the validity of an observed finding. However, it should be noted that blinding is not always warranted in rehabilitation (21). For instance, when the study question is about effectiveness in routine health care, blinding might be questionable. In addition, when the study question is about effectiveness in routine health care, blinding is also questionable. Indeed, when it comes to translating the studied intervention to the real clinical world, the patient will

TABLE 3 | Methodological problems in rehabilitation research (14).

Categories of issues	Type of issue
Control group	Difficulties in having a "placebo" group. For some interventions, it may be possible to reproduce the non-pharmacological intervention using a placebo device but, most of the time, the control group will receive no intervention. The placebo effect of the intervention could therefore not be assessed.
Blinding	Difficulties in blinding participants and personnel. Indeed, participants are aware of their group of appurtenances since, they will either receive the intervention or not. For the staff, it is a challenge to ensure that the person applying the treatment is not the same as the person carrying out the measurements.
Randomization	Limited participant's acceptance of randomization. Participants are often hesitant of being randomly assigned to one group and, particularly to the control group with no intervention offered. Patients are often in pain or suffer from important mobility issues/disabilities. Therefore, when they are included in the control group, they only need to perform the measurement at the entry and at the end of the study and they do not perceive any benefit from participating in the study.
Ethics	Unacceptability to use a control group that withholds or delays treatment. Patients assigned to the control group often receive no intervention and are required to not modify their current rehabilitation.
Eligibility	Existence of multiple comorbidities that restrict the inclusion of participants. Therefore, there is an insufficiency of eligible participants in one unique site of recruitment and multisite studies often have to be organized. Difficulties to recruit participants with pathologies that can be considered as similar on the phenotypic level.
Monitoring of interventions	Complexity of some interventions that makes it difficult to monitor their administration.
Confounding factors	The multifactorial rehabilitation of PRM patients that makes difficult to identify the true intervention effect and differentiate the aspects of natural recovery processes within the course of their rehabilitation.
Participant attrition	Interventions proposed in PRM research may be long in term of follow-up, which increases the risk of participant attrition.

be aware of the treatment he/she will receive, thus a combination of the treatment effect *per se* and a certain degree of placebo effect will occur (21).

In the context of PRM research, there are two important risks of bias. Performance bias corresponds to (behavioral) changes that occur due to the knowledge of interventions allocation, from either the researcher or the participant or both. Indeed, a patient who knows he/she is receiving a new therapeutic intervention is more likely to experience a placebo effect (i.e., clinical improvement in the absence of any 'true' intervention). This placebo effect will bias the results as it will be impossible to disentangle the treatment effect (due to the intervention) from the improvement due to the patient's expectation (i.e., placebo effect). In addition, the assessors, who are not blinded of the treatment allocation, might be influenced as well and prone to oversee clinical enhancements. Finally, the care-givers might also be biased, and subconsciously provide care that differs between the treated and the control group. This bias can be prevented by using appropriate blinding for both the participants and the researcher or the clinician providing the treatment. It can also be minimized by using adequate placebos (22); however, as said previously, it is not particularly simple to develop double-blind placebo controlled trials in PRM.

The other main bias is detection bias, which is defined as systematic differences between groups in how the outcomes are determined, which can cause an overestimation or, on the other hand, an underestimation of the size of the effect. Such bias can easily be prevented using randomization procedures to ensure that the two groups (active and placebo) are homogenous and comparable.

Many trials conducted in PRM are open-label studies (i.e., the researchers and participants know which therapy is being administered), which may induce an important placebo effect both for the patients and the researcher, thus inducing important biases on the outcomes (23). Such open-label designs, even if they can bring some important insights on the possible efficacy of an intervention as well as its safety and feasibility, do not allow for any conclusion to be drawn regarding its actual efficacy.

Beside open-label studies, in PRM, most clinical trials either use no intervention, standard care or other conventional interventions as a control group. These (non-)interventions might not only be problematic in term of the amount of treatment received (the intervention group will receive more therapy than control group), but make blinding impossible and randomization complicated. Therefore, the development of appropriate placebo or sham procedures is crucial. One possibility to develop valid controlled conditions in trials assessing active rehabilitation strategies (e.g., the effect of a robotic rehabilitation on muscular strength in patients with MS) would be to apply another *active* intervention not expected to cause any effect (e.g., robotic rehabilitation using movements too slow to impact muscular strength, the use of aerobatic vs. anaerobic exercises as a controlled condition). In this context, a collaboration with companies to develop appropriate placebo devices and protocols would be beneficial [for instance, a shockwaves head was manipulated by the company to mimic but not delivering shockwaves and unsure a proper blinding (24)]. Nevertheless, if such approaches might be enough to ensure a proper blinding of the patients, it might fail to properly blind the therapist.

To add to these challenges, rehabilitation strategies are highly heterogeneous both at the intra and inter individual levels. Indeed, based on the patient's level of impairment (i.e., rehabilitation based on deficits), the techniques and amount of therapy a patient will receive can vary for the same pathology. In addition, for the same patient, depending on other clinical factors such as fatigue, emotional status or concomitant treatment, sessions of therapy can greatly differ from 1 day

to another. Of note, in other fields, such as neuromodulation and non-invasive brain stimulation, personalized approaches using for instance, electrode montages based on the patients' individual brain lesions, are being developed, which will greatly reduce the homogeneity of the intervention provided. While such heterogeneity might be seen as a limitation in research, it is crucial for patients' management. One solution to be able to quantify the amount of therapy provided could be to monitor the time and the load for the patient using the Borg scale, the rating scale of perceived exertion (25). These parameters could then be taken into account in the statistical analyses. Additional parameters (e.g., number of repetitions, distance covered, strength) could also be considered based on the intervention.

In addition, the heterogeneity of the intervention is also a challenge given the heterogeneity of the disease or studied population (see next section). In this context, models have been proposed, such as the FITT model for exercise (26), accounting for the multidisciplinary intensity of care based on the Frequency, Intensity, Time, and Type of exercise proposed. Such program may offer more flexibility to the proposed rehabilitation program based on specific guideline, allowing to quantify the amount of exercise performed by patients.

In some cases, having a controlled group is impossible. For instance, when it comes to testing the efficacy of a prosthesis, it is almost impossible as this would require the development of a 'sham' prosthesis. This is not only extremely costly but the setting of appropriate and true sham parameters is almost impossible to achieve. In addition, it might be ethically questionable not to offer a potentially beneficial treatment to half of the participants. To circumvent this issue, one could offer the treatment to the control group after the study completion. Another challenge in PRM, is that placebo treatments need to be efficient for blinding over longer periods of time, as most therapies are provided for several weeks or even months. This makes the blinding and masking aspects even more challenging.

Even in controlled studies, successful blinding is often hard to achieve in PRM (22, 27). In a systematic review evaluating the amount of RCTs correctly reporting blinding strategies, the authors found that an important majority of trials do not correctly report it, but most importantly, that trials with positive results tend to have lower reporting rates for correctly reporting blinding (28). The fact that unblinded trials report more positive results compared to blinded studies is well known, not only in the field of PRM. Therefore, more effort is required to develop reliable blinding strategies and clearly report them in study protocols. One simple but costly solution is to have two clinicians or researchers involved in the protocol, one responsible of applying the intervention (active or placebo/sham) and the other one in charge of the assessments. This also implies that the patient has to receive the study interventions in a separate room (as opposed to conventional physical treatment often performed in large rooms where several patients receive their care simultaneously). Even if considered simple, this strategy might be complicated to implement as it requires additional financial resources.

THE CHALLENGE OF POPULATIONS' HETEROGENEITY

To add to these existing methodological challenges, the population targeted in PRM research is often heterogeneous in terms of symptomatology, even within a same pathology. Traumatic brain injury (TBI), for instance, encompasses a wide variety of clinical symptoms ranging from mild (e.g., troubles to concentrate, headaches) to moderate (e.g., impaired executive functions, ataxia) and severe (e.g., disorders of consciousness, paresis), while it is often studied in interventional studies (e.g., cognitive-behavioral interventions, non-invasive brain stimulation). TBI is therefore complex to recruit a homogeneous study sample. One solution is to apply stringent inclusion criteria in terms of symptoms however this does not only compromise the recruitment; it also decreases the external validity of the study. The clinical translation of a therapeutic method tested on a highly selected population is indeed poor.

This heterogeneity combined with the aforementioned difficulties in designing methodologically robust studies and the recruitment issues, leads to small sample sizes and many studies are thereby statistically underpowered. The lack of standardization of the outcomes further makes the comparison between studies complex. All these factors lead to a poor representation of these studies in meta-analyses. The same applies to stroke patients where the heterogeneity of the populations in terms of type of stroke, clinical presentation and duration of the symptoms, makes the integration in meta-analyses complicated, despite an important amount of published studies.

Another factor specific to PRM (but also other fields such as cancer research) is the evolving aspect of some diseases. Indeed, neurodegenerative diseases such as MS or Alzheimer can have varying patterns of evolution with, for instance, important decreases in function over a short period of time followed by longer periods of disease stability. These evolutionary patterns can be very different from one patient to another and can further compromise the homogeneity of study populations, within a same group (e.g., experimental group) or between groups (experimental and control).

Finally, another contributing factor to the population's heterogeneity is the presence of comorbidities. Potential study candidates often suffer from other pathologies than the targeted one (e.g., diabetes, hypertension, arthrosis) and these varying profiles are very difficult to control for. It is however important to take these comorbidities into account notably because some of them may be risk factors for the targeted condition (e.g., diabetes is a risk factor for chronic tendinopathy).

All these aspects may be seen as barriers for conducting robust research in PRM and discourage researchers. However, there are several ways to tackle them, pending sometimes a shift in clinical and scientific routines (29). First, there is a consensus that larger samples have to be included. To do so, the field has to move from a segregated model to an open and collaborative network. Large multicenter trials, open science practices and registration of protocols are important and efficient paths to follow. Second,

the current state of reporting regarding baseline patients' medical condition is still too low but could easily be improved based on standardized reporting guidelines and Common Data Elements [e.g., (30, 31)]. Finally, while heterogeneity can be perceived as a limitation from a purely methodological standpoint, it corresponds to the clinical reality and could be embraced as such. Pending sufficient sample sizes, analytical approaches accounting for the populations' heterogeneity can be used: clustering methods, normative modeling, and measures of individual changes, for instance.

Since there is no way of getting completely rid of the heterogeneity in populations for PRM research and given the high propensity of this field for individualized treatment approaches, measures should be taken to account for it and the study design, and the analyses should be planned accordingly. This can only be managed through a collaborative and inter-disciplinary approach.

In addition, a proper reporting of the population is crucial both for the generalizability of the findings of RCTs (32) and for consequent systematic review (33). So far, the percentage of adequate reporting is poor, thus limiting the generalizability of RCTs' results in clinical settings (i.e., reduced effectiveness). Future clinical trials should provide a clear description of the patients' selection and the study setting, as well as clear characteristics of the studied population in term of patients' functioning, comorbidities, as well as behavioral, environment and inequity factors (32).

IMPROVING RECRUITMENT AND ADHERENCE

Recruitment

Recruitment for PRM research, just as for most other research topics, can often be challenging. Clinical studies in this domain focus frequently on patients, each with their own life prior to the injury, and that continues despite it. This is different to studies done on a cellular level, or on animal models, as there is a high variability in behavior.

Research in this domain must also take into account a large number of variables that are a necessity for patients to continue functioning, despite their injury. For example, there are ethical implications, as well as research implications, by giving pain killers to subjects implicated in pain-management studies.

Difficulties encountered are also linked to the large number of monocentric studies run concomitantly. Patients that have very few co-morbidities, and who are ideal candidates, are sought after, making recruitment all the more difficult, the more studies are simultaneously run. As there is a large interest in running these studies in localized, well controlled environments, such as rehabilitation centers, or retirement homes, the population is often limited to the capacity of the centers, making recruitment more challenging. As stated above, running larger, multicenter studies, despite the logistical challenges, could help counteract this limitation.

There are also time constraints that can limit patients' willingness to participate in studies, in addition to their rehabilitation. There seems to be relatively little free time in between therapy, care, needed rest, functional daily live activities and socialization requirements (34, 35). It stands to reason that including novel or innovative technologies might increase recruitment, out of curiosity, personal beliefs, or lack of alternative solutions (36–38). Unfortunately, this doesn't always hold true (39), as new technology has its downfalls (ie: complexity of use, especially with an older population), though specifically targeted models might inverse this trend (40). Another setback is the difficulty in implementing a placebo treatment with these new technologies.

Patients might also simply lack awareness of clinical trials. Certain rehabilitation centers, associated with universities or research labs, have scientific coordinators, to help manage multiple studies that take place simultaneously, but it is usually the healthcare providers that recruit patients for studies (41).

Adherence

Adherence is also a challenge for longitudinal studies. Motivation, beliefs, but also factors linked to the rehabilitation program (fatigue, discomfort, time constraints etc…) can increase risks of dropouts. As recovery tends to slow down, and results are sub-satisfactory, adherence can become challenging. There are steps that therapists and researchers can take to try and convince patients to stay the course such as explaining the benefits of the new technique, and setting obtainable goals with the patient instead of for the patient (42).

A large proportion of patients requiring rehabilitation are elderly. One of the leading factors influencing response rate (i.e., nonparticipation or lack of adherence) is age (though the data is controversial on exactly how age influences adherence (though the trends seem to point toward lower adherence during midlife (other occupations that take precedent), and with elderly subjects (physical or cognitive disabilities that hinder adherence (43). Other factors that negatively affect response rates are smoking, educational status and income which are also linked to higher disabilities levels for a variety of illnesses, such as arthritis (44), stroke (45), or lower back pain (46).

In the case of athletes, when rehabilitation is investigated, there seems to be similar adherence problems, with a very high percentage of participants reporting low adherence. This usually has to do with the very busy timetables, and many athletes want a "quick fix" (and therefor dropout relatively quickly). However, in a small proportion, some participants report over-adherence (where subjects overwork, or over train, which could lead to further injuries) (47).

Adherence depends on a variety of factors such as intrinsic motivation, speed of results, and the hassles linked to rehabilitation. These can be improved if medical professionals continue to motivate patients (48) through education and explanations.

Patient adherence to rehabilitation, and strategies to improve it, were recently put to the test. With the lockdown following the COVID-19 pandemic, patients needing rehabilitation found themselves isolated and unable to receive care. Telerehabilitation

has been shown to be a promising alternative to face-to-face rehabilitation during the pandemic (49, 50).

Going back to the notion of BCTs vs. RCTs, patients' adherence might be limited in the context of RCT which required a strict compliance to the study protocol, thus increasing the attrition rate. On the other hand, as regard to effectiveness research, BCT might be preferred, limiting the risk of drop-out as study criteria represent the real clinical setting (51). On the other hand, the difference in baseline between the studied groups in BCTs should be taken into account as this can seriously influence the study outcome. However, lack of adherence in RCTs is an important limitation to the generalizability of their findings.

Funding

On a global scale, approximately one in every three adults will require rehabilitation over the course of their injury or illness (52). The causes span across a wide variety of pathologies, such as musculoskeletal, neurological, respiratory, cardiovascular and oncological disorders. As research in surgical and medical treatments continue to improve, so must PRM. However, as an example in the United State (i.e., NIH) in 2021, approximately $864 million was spent on rehabilitation overall (making it 64th) and approximately $220 million were spent on research in physical rehabilitation (making it 215th) out of the top 299 research disease topics (53). This ranking clearly shows that many funding agencies do not privilege clinical and translational research, while it is the last stone laid to confirm the efficacy of an intervention in real clinical practice.

DEVELOPING APPROPRIATE QUANTIFICATION STRATEGIES

In PRM, homogeneity and quantification of rehabilitative strategies is challenging. Indeed, as discussed in previous sections, the problem of heterogeneity is particularly present in rehabilitation. Rehabilitation can vary strongly from one therapist to another (experience, age, knowledge of therapists, choice of using "standard treatment" vs. "innovative treatment," etc.), from one patient to another (comorbidities, patient's levels of cognitive deficit, patient willingness, etc.) and from one moment to another (emotional status, fatigue, etc.). In general, treatment and techniques need to be adapted to the level of physical and cognitive capacities of the patients (i.e., refers to the concept of *rehabilitation based on patients' deficits*). Therefore, quantifying rehabilitation techniques remains complicated. Yet, it is essential to use evidence based practice in all areas of medicine.

One solution to try to quantify the efficacy of rehabilitation is the use of questionnaires/scales. Parameters such as patient's walking capacities or balance can easily be done using validated tools.

However, clinicians and researchers are often confronted with challenges which are listed below (sections 6.1 to 6.3).

Of note, beside evaluating quantifying the efficacy of a specific intervention, the concept of System Impact Research aims to assess the impact of the health care system or cares pathways on patients in the context of rehabilitation (18). Such system is important to evaluate the impact of health policies on patients' health and the effectiveness of (novel) multidisciplinary rehabilitative pathways for specific diseases.

The Use of Validated Tools

When different tools exist for a same purpose, researchers and clinicians would have to make a choice. One of the criteria of this choice should inevitably be the fact that the tool is/is not validated. However, it is not always clear what "validated" implies. Before using a scale or a questionnaire, it is recommended to verify the measurement properties of the tool. Ideally, the tool should have been tested on a similar population for its ability to measure what it claims to measure (i.e., its "validity"), its capacity to stay stable over time if the clinical status of patient is also stable (i.e., its "test-retest reliability"), its capacity to not be administrator-independent (i.e., its "inter-rater reliability"), its capacity to detect changes over time if the clinical status of the patient evolves, in a positive or negative way (i.e., its "sensitivity to change) and also, its homogeneity (i.e., its "internal consistency") (54, 55). To know if a scale/questionnaire has been validated or not, it is necessary to identify scientific publications referring to this potential validation. When a clinician or a researcher in PRM plans to use a tool for a particular measurement, it is important to check if the tool has been validated specifically for this measurement. Indeed, it is likely that a tool has been validated analytically but not functionally or for one anatomical site and not for another. If the tool has not been validated for the specific target measurement, a validation study (i.e., analyzing clinometric properties of the tool in the target population) should be done prior using this tool for any clinical/research purpose.

The Use of Tools That Have Been Translated and Validated in Their Own Language

Another important challenge is the availability of the tool/questionnaire in different languages. Indeed, a tool/questionnaire/scale is initially developed and validated in one unique language. If a French hospital desires to use a questionnaire that has been developed in English, and only been validated in English, the French researchers will have to first translate this tool then validate the translation to ensure that the translation has been correctly done. This process may be long and requires the use of a standardized methodology (56). For a scientific translation, it is necessary to follow different steps: first, the questionnaire should be translated from English to French independently by two bilingual translators, who have French as mother tongue. Second, the two translators should meet and agree on a first version of the translated questionnaire. Third, the translated French questionnaire needs to be back-translated independently by two bilingual translators, who this time have English as mother tongue and who are blinded to the original version. Four, a meeting should be organized with all the translators to agree on a second French version of the questionnaire, taking into account results from the back

translations. Fifth and lastly, the pre-final translated version should be pre-tested on a sample of target population to ensure the translation is clear, understandable and free of language or grammatical errors. Once this last step is finalized, the version of the translated questionnaire may be considered as final and may be tested for its measurement properties.

The Use of Generic vs. Specific Tools, Questionnaires or Scales

Clinicians and researchers should also be aware of the difference between generic scales and specific scales, the last one being specific to some populations and pathologies and being more sensitive to change. Because of the importance of specific evaluations depending on the clinical states of populations, many diseases-specific questionnaires have been developed in the last few years. In P&MR, the evolution of some pathologies could be very complex and may impact the choice of tool to use. Specific tools, more sensitive to change, may be very useful to evaluate, for example, a motor deficit at one moment and the short term impact of rehabilitation but could be less useful to use once the patient would have recover its motor capacities which is the case of the Medical Research Council (MRC) Scale for Muscle Strength (Lovett), widely used but not capturing fine improvement in motor function (57). Conversely, more generic tools, less sensitive to change, could lack the sensitivity to identify improvement following a particular rehabilitation but could be more useful to follow prospectively the evolution of a patient during their rehabilitation.

With better ability to research scientific literature, clinicians and researchers may be able to identify better tools to adequately assess outcomes of a rehabilitation procedure in a particular population. The use of appropriate, targeted and validated questionnaires/scales could allow for a better standardization in quantification of results in PRM practices.

Analyses

In rehabilitation research, most assessment tools and outcomes measurements are not continuous but ordinal (e.g., Barthel Index, Health Assessment questionnaire), meaning that the distances between the raw score points are unequal and common statistical approaches (parametric tests) are invalid (58, 59). For such cases, statistical procedures (non-parametric test) are available for such ordinal outcomes (59).

As most interventional studies in rehabilitation and health in general wish to calculate a change score, or use values from ordinal scales in procedures such as ANOVA and regression, then the challenge is to provide a transformation of such scale to the interval level. In this context, Rasch proposed the Rasch analysis, which is a psychometric technique allowing researchers to construct alternative forms of measurement instruments (60). For a detail description of the procedure see (61).

Besides the Rasch analysis, depending on the data acquired (categorical, ordinal, continuous) and their distributions, specific statistical tests could be performed (e.g., parametric or non-parametric statistics). Several tools have been developped to help researcher finding the appropriate test based on the type of data they collected (62, 63).

ETHICAL CHALLENGES

One important challenge in PRM is the ethical aspects of conducting trials in patients who might suffer from cognitive deficits. Based on the declaration of Helsinki, guidelines have been developed to ensure that consent to participate in a research protocol is done based on the patient's best interest. To comply with this regulation, three conditions must be met, namely: *patient capacity* (the patient's ability to understand the nature of the research, as well as its risks and benefits, in order to make an informed decision), *voluntariness* (freedom from undue coercion, be it deliberate or unintended) and *disclosure* (the provision of all information necessary for the potential subject to assist them in the decision-making process).

However, a significant proportion of patients in rehabilitation medicine have cognitive deficits, of varying severity, that can compromise the patient's ability to 1. understand the ins and outs of a research protocol, and 2. be able to make a lucid decision about his or her interest in taking part in a research protocol. In this context, the researcher must be vigilant in ensuring that the subject's participation is truly informed and voluntary. If this is not the case, the intervention of a relative and/or the patient's legal representative will be necessary.

Since rehabilitation care is often lengthy, spanning several years, another ethical consideration is the number of protocols a patient may participate in. Indeed, it is possible that some patients may be recruited for multiple studies throughout the course of their rehabilitation. According to the ethical principle of justice, which examines the distribution of the costs and benefits of living in a society, no group should bear a disproportionate burden of participation in research. For patients whose stay exceeds a certain length of time, it might be reasonable to put guidelines in place so that these patients are only invited to participate in a certain number of research projects, perhaps one per year or one every two years, to ensure that they do not bear an excessive burden in this area.

CONCLUDING REMARKS

To conclude, we here summarize the key points discussed in the previous sections.

Regarding the study design, RCT are the gold standard, which provide the strongest scientific evidence necessary to promote evidence based practice. However, alternative such as observational BCTs can be choosen if the aim is to assess the effectiveness of a program or healthcare pathway (as opposed to the efficacy of a specific intervention). Other studies can also be conducted and bring useful information, such as cohort studies in term of risk factors of developing a disease or exploratory uncontrolled open-label study, which can bring important insights on the possible efficacy of an intervention as well as its safety and feasibility. In parallel, pragmatic trials (a type of RCT) are designed to evaluate the effectiveness of an intervention in real-life routine practice, and are well suited for PRM. Importantly, no matter which design is chosen, it is crucial to follow the

available checklists and guidelines (e.g., CONSORT checklist for RCT).

When performing a RCT, choosing an appropriate controlled condition can be complex, as is ensuring adequate blinding. The use of active placebos may be an elegant solution, however, it cannot be applied to all interventions. If the blinding of both the participant and the evaluator is questionable in an RCT, this must be recognized as a limitation since performance bias cannot be excluded.

In some cases, is also important to quantify the amount of therapy provided which may vary among participants due to population heterogeneity. A detailed procedure and systematic reporting of the intervention are therefore critical. To avoid biases linked to population heterogeneity, applying stringent inclusion criteria is recommended; however, it also decreases the external validity of the study and may leads to smaller sample sizes and lower statistical power.

To overcome the issue of sample size and increase the external validity and thus enhance the changes for a successful clinical translation, large multicenter pragmatic trials, despite the logistical challenges, should be implemented. Validated scales and common data elements should be used to ensure an exhaustive reporting.

Regarding recruitment and adherence, while they represent an extra challenge in PRM given the length of most intervention, the communication and reliability between the clinician/research and the patient is key. Similarly, all research undertaken must follow the declaration of Helsinki to ensure that the research protocol is done based on the patient's best interest.

To sum up, developing robust experiment design in PRM might be challenging. However, many solutions exist to tackle potential biases. When these biases are unresolvable, clear and honest reporting of the limitations is essential. Therefore, a thorough knowledge of these challenges is crucial.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Pursuing Quality Education in Physical and Rehabilitation Medicine in Japan

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In Japan, medical education and training are the combined responsibility of two ministries namely Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Health, Labor and Welfare. The medical education system underwent a major transformation in August 2021 making it a seamless clinical education blending pre-graduation and post-graduation training. Not all universities offer rehabilitation medicine curriculum. Furthermore, where rehabilitation medicine is taught, the curriculum content is not standardized. All medical students sit for a common national medical practitioner qualifying examination. However, only a few questions on Rehabilitation Medicine are included. The personal experience of the author's teachings in rehabilitation medicine at Saga University medical school is described. Emphasis is placed on experiential learning on subjects that are current and state-of-the-art in Japan including robotics. It is aimed at promoting inspired motivation for the students to pursue specialized training in rehabilitation medicine. Japan can take lessons from the European Union's white book on Physical Medicine and Rehabilitation as well as the International Society of Physical and Rehabilitation Medicine core curriculum. In addition, the Rehabilitation Medicine education system can be further improved through a well-coordinated preclinical and clinical medical education. There is also a need to expand the rehabilitation medicine field and address the gaps with other specialties.

Keywords: quality, education, Physical and Rehabilitation Medicine, motivation, curiosity, digital transformation

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INTRODUCTION

The objective of this paper is to describe the Japanese medical school education system highlighting the rehabilitation medicine component at undergraduate and postgraduate levels.

CURRENT MEDICAL EDUCATION SYSTEM

Since its early beginnings in 2021, medical education has undergone transformation toward meeting the needs of the Japanese population. **Table 1** shows the changes in the medical school education system since 1991 (1). In August 2021, a landmark development took the form of a seamless clinical education for under and post graduate medical students as shown in **Figure 1** (2).

It has been common practice that high school graduates can pursue medical studies which conventionally consists of 6 years of medical education governed by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). An internship of 2 years follows, and this is

TABLE 1 | Medical education in Japan before 2021.

Before 1945 (end of World War II)	**4-year education (2-year basics, 2-year clinical medicine lectures, doctor's license is automatically granted)**
1945	Started efforts to improve pre-graduate medical education
1946	Resumed national examination for doctors
1948	Internship system started
1968	Clinical training system implementation 1 year
2004	Two-years clinical training under the law (formal internship)
	The doctor training course has a total of 8 years, 6 years before graduation and 2 years after graduation training.
2016	Medical education model core curriculum started
2020	Plan to start of clinical training that integrates qualifications and ability requirements in pre- and post-graduation

Based on reference (1).

under the governance of Ministry of Health, Labor, and Welfare. Specialty education (residency) is then continued under the latter ministry and lasts for 3–5 years depending on the specialty. For Rehabilitation Medicine, the residency training is 3 years. All doctors are then expected to continue with lifelong education.

The August 2021(**Figure 1**) revised seamless clinical education blends pre-graduation and post-graduation training aimed at standardizing the expansion of the medical school education framework. Pre-graduation medical education consists of preclinical medical education and clinical clerkship. Preclinical medical education is provided by education specialists using a schedule standardized for school education. Clinical clerkship is conducted in a community practice likened to an apprenticeship.

Up till now, many medical schools throughout Japan have offer rehabilitation medicine courses, but the curriculum content is not standardized. Some offer up to 20 h, while others just offer a few hours of rehabilitation medicine teaching.

Numerous universities offer only a few days of rehabilitation clinical training in clinical clerkship. Furthermore, the National Medical Practitioners Qualifying Examination has included only a few questions related to rehabilitation medicine.

Only 2 to 3% of interns learn about rehabilitation medicine through their respective postings. This indicates that most of them are not exposed to rehabilitation medicine, hence very few interns venture into that field. Those who intend to make rehabilitation medicine their specialty have to learn the majority of their practice during the 3 years of residency. But there are far too few instructors in that sector of medical education.

CURRENT NEEDS FOR REHABILITATION IN MEDICAL SERVICE

Rehabilitation medicine is a unique field that focuses on activities. It needs to meet the major demands placed upon it in recent years by Japan's aging society. The average lifespan in 2020 was 81.64 years for males and 87.74 years for females[1], making Japan one of the countries with the longest life expectancy in the world. In 2020 the aging rate was 28.8%[2]. Generally speaking, one's healthy lifespan is approximately 10 years shorter than one's overall life expectancy, and as a result an increased aging rate is directly related to an increase in the number of individuals living with disabilities. With the advances in acute medical care increasing survival rates, residual polymorbidity and decreased reserve capacity in the elderly lead to increased numbers of old people aging with disabilities. This results in the increase in demand for rehabilitation services.

When one examines trends in occupations in rehabilitation in Japan, one notes that physical therapy and occupational therapy came under national licensing status in 1965. Speech-language-hearing therapists came under national licensing status in 1997. These professionals took responsibility for highly specialized forms of rehabilitative medical care for children and disaster victims with disabilities. The acceleration in the number of older persons in the 2000s resulted in the increase of the total number of therapists by 8.7 times, from 32,400 in 1998 to 282,400 in 2018.The specialization system for physiatrists (rehabilitation physicians) started in 1980 as one of 18 clinical specialties. Although the number of physiatrists showed an upward trend, in 2019 there were just 2,531, i.e., only 1.3% of specialists in all fields[2].

With regards to healthcare services covered by the medical insurance system, rehabilitation fees account for only 5% of all medical costs (3, 4). In the midst of social conditions in which there is a major effort to reduce total medical costs, the clear expansion of rehabilitation medicine is causing stress amongst stakeholders.

PERSONAL EXPERIENCE AT SAGA UNIVERSITY MEDICAL SCHOOL

The author has been passionate about and has dedicated herself to medical education, clinical practice, and research at both universities and university hospitals since her graduation in 1984. Education is the cornerstone of the sustainable development of rehabilitation medicine and standards (3). For the training program in rehabilitation medicine have been set. At Saga University, this is as shown in **Table 2** (5).

Japanese rehabilitation medicine education demands that students learn a great deal, and exemplary services and research have emerged amongst the crème de la crème of the specialty. At Saga University there are only two rehabilitation medicine instructors for both the pre- and post-graduate levels. Medical School classes are small. The two are also responsible for engaging approximately 3,000 patients per year. In addition, they are responsible for handling approximately 28,000 physical therapy, 10,000 occupational therapy and 7,000 speech-language-hearing therapy cases per year.

[1] Available online at: https://www.mhlw.go.jp/toukei/oshirase/.

[2] Available online at: https://www8.cao.go.jp/kourei/whitepaper/w-2021/zenbun/03pdf_index.html.

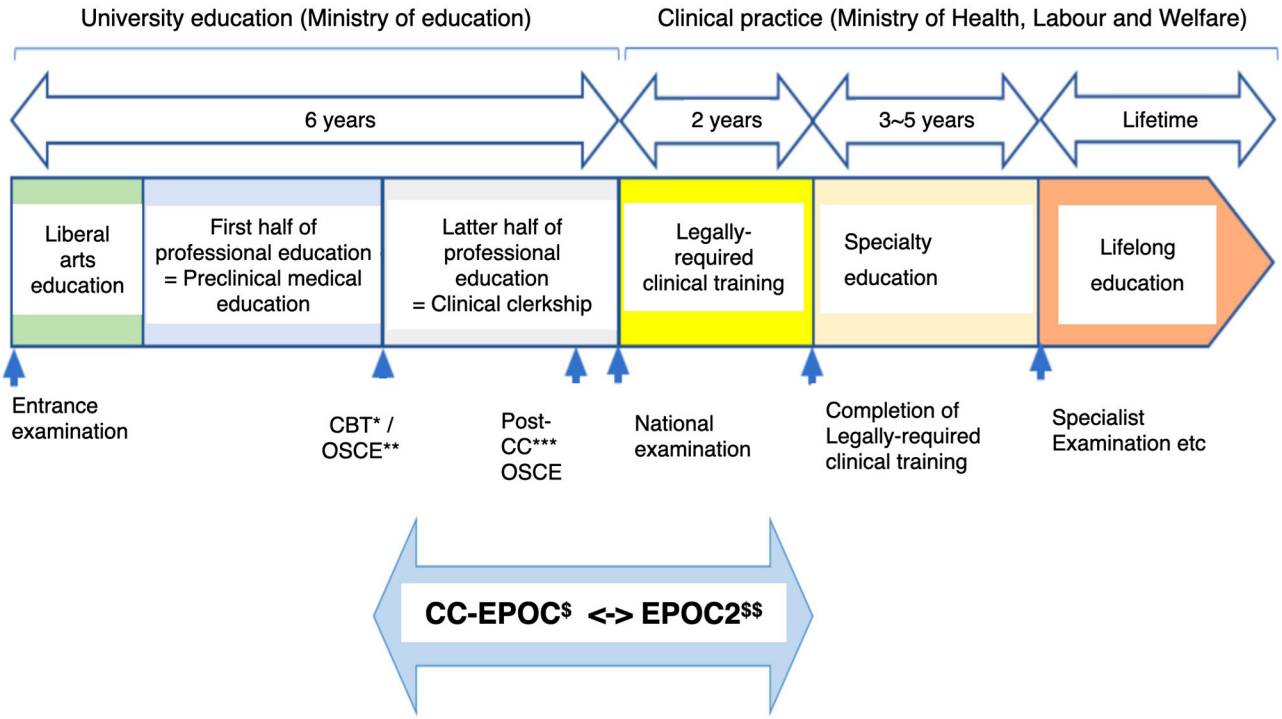

FIGURE 1 | Seamless clinical education before and after graduation of medical school in Japan since August 2021. *Computer based testing. **Objective structured clinical examination. ***Post-clinical clerkship. $Clinical clerkship-evaluation system of postgraduate clinical training. $$E-portfolio of clinical training.

TABLE 2 | Duration of rehabilitation medicine training for medical students and residents at Saga University.

Grade	Time
1st grade of medical school	6 h (visit)
4th grade of medical school	6 h (lecture)
5th grade of medical school	Selective training
6th grade of medical school	Selective training
Resident 2nd grade	Selective training

In spite of lack of academic resources and overwhelming workload in clinical practice, research, and education, the author has attempted to provide "handmade" medical education. One is through clinical education with the use of rehabilitation robotics, including virtual reality (VR) and myoelectric prosthetic hands. These are among the most advanced medical devices that can stimulate the curiosity of young people (**Figure 2**) (6). At Saga University Hospital, Japan's first "Robot Rehabilitation Outpatient Care" was launched on October 1, 2014. Its purpose was to create a high-quality rehabilitation healthcare system that utilizes rehabilitation robotics. Patients are referred from all over Japan, which ultimately contributes a critical mass for an education system (7, 8). This initiative utilizes participatory clinical training for medical students, interns, and residents. It is an education system that allows independent participation making it easier for students to comprehend what is being taught. Experience in rehabilitation medicine deepens making it useful for solving problems using artificial intelligence (AI). Advances in education that utilize these kinds of digital transformation (DX) methods have accelerated during the COVID-19 pandemic. They can in fact be used to supplement actual, in-person training which had been restricted by the pandemic.

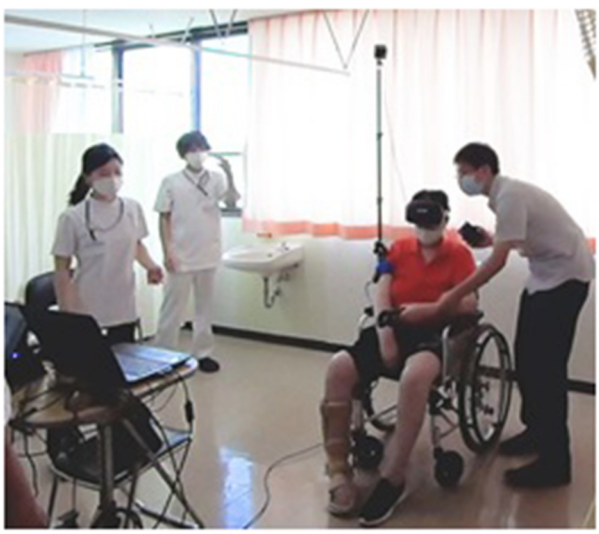

FIGURE 2 | mediVR KAGURA® (VR, virtual reality).

DISCUSSION

The August 2021 landmark initiative taken by two distinct Ministries responsible for churning out medical specialists is promising. It brings Japan closer to the current practice in Europe that evolved out of the sheer need for standardization for the European Union where medical positions among countries is seamless. Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) along with its partner Ministry of Health, Labor, and Welfare can take lessons from this (?) years of collaborative work amongst member countries The European Union's white book on Physical Medicine and Rehabilitation and the International Society of Physical and Rehabilitation Medicine (ISPRM) core curriculum can provide an excellent insight to an educational and clinical framework (refs?). However, it is necessary to keep in mind that clinical practice is not a pure science and that it is a system that comprises many kinds of wisdom, including skills that have been developed over a long history of tinkering. Thus, clinical education should not be just school education or just apprenticeship, but rather it needs to be both.

Motivation is an important element in educational success (9). Curiosity, the bedrock of internal motivation for learning, along with inspiration and external motivation can be provided through apprenticeship that can make up for the aspects of the school education model that are lacking. When considering these issues, one realizes that the education system should not be constructed in such a way as to encourage overcrowding but rather should have slack in certain circumstances. The creation of a flexible education system that takes advantage of the unique features of rehabilitation medicine, while at the same time maintaining a sufficient grasp of medical education as a whole, is likely to be the key to the future of rehabilitation medicine. Importance should be placed on learning clinical expertise with a focus on actual practice and on promoting "inspired motivation," which is a type of external motivation found, for example, in apprenticeship. In addition, through the adoption of the new concept of "activity" into medicine, curiosity, which is a form of internal motivation, will be further emphasized. The author believes that there is a need to emphasize this within the limitations of the undergraduate education system. Strengthening the rehabilitation medicine studies at medical school level serves as a sustainable feeder to a continuous birth of rehabilitation physicians who can serve the ever-increasing needs of an aging population such as in Japan. Only then will the World Health Organization's (WHO) realization of meeting the rehabilitative needs of the 2.4 billion world population be met (ref). Japan is particularly challenged by gaps in numbers of high schoolers, medical students and interns who are yet to be exposed to rehabilitation medicine through their education experience. Though the numbers of rehabilitation physicians are far too small to meet the demands of student teachings, the combined effort with rehabilitation inter-,trans- and multi-disciplinary teams through a structured rehabilitation medicine curriculum can be key in tackling this problem.

CONCLUSION

Highlighting the rehabilitation medicine component at undergraduate and postgraduate levels of the Japanese medical school education system has revealed the shortcomings of clinical education in Japanese medical education. In order to solve this problem advances must be made in coordinating pre-clinical medical education and clinical clerkship. In the field of rehabilitation medicine education, there is a need to solve specific problems related to coordination with pre-clinical medical education while keeping in mind effective clinical clerkship education. In the meantime, there is a need to expand the field and address the gap compared to other specialties. What is necessary when doing this is not to disregard the inspired motivation of apprenticeship that promotes sufficient motivation and curiosity.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Effect of an interprofessional small-group communication skills training incorporating critical incident approaches in an acute care and rehabilitation clinic specialized for spinal cord injury and disorder

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Aim: To investigate the impact of site-specific inter-professional small-group communication skills training (CST) that incorporates critical incident approaches to learning on patient satisfaction with communication.

Setting: Rehabilitation clinic specialized for spinal cord injury/disorder (SCI/D).

Methods: Retrospective observational cohort study design using patient and health-professional self-report data. Data for patient satisfaction with communication were collected in 2014 (existing records) and each year from 2015 to 2021 (post-program; volunteers) using the MECON survey.

Results: Fifteen basic (n = 161 participants), 16 refresher (n = 84), and five short (n = 17) CST seminars were conducted. Overall, 262 employees (105 physicians, 63 nurses, 36 physio- and occupational therapists, and 58 others) participated; 92 participants (response rate 37.6%) responded to feedback surveys. They rated the seminars positive concerning the alternation between theory, discussion, and practical exercise in 91.3%, and rated the length of the training ideal in 80.2%. Post-program patient satisfaction overall increased from 83.1% (confidence interval (CI) 2.6%) to 90% (CI 0.8%; R2 = 0.776; p= 0.004). It was higher in specific communication-related topics: "receiving information" (81.1%, CI 3.1–90.2%, CI 1.0%; p = 0.003), "being able to bring in concerns" (83%, CI 1.0–90.8%; R2 = 0.707; p = 0.009) and "being treated with respect" (89.4%, CI 2.6–94.4%, CI 0.8%; R2 = 0.708; p = 0.004).

Practice implications: Inter-professional CST is feasible and well accepted by professionals from various professional groups. During seven years of continuous training, independent patient ratings of satisfaction with professional communication have improved significantly. Participants attest to the training's high credibility and usefulness in everyday life.

KEYWORDS

teacher training, health communication, interdisciplinary communication, rehabilitation research, intersectoral collaboration, patient-centered care, spinal cord injury, pragmatic clinical trials

Introduction

Communication in medical rehabilitation is widely accepted as a prerequisite for patient-centered care and collaboration among health care professionals (HCP). A core element of patient-centered care is HCP's genuine interest in patients' perspectives. Although there are different theoretical models of patient-centered communication (PCC), the core element of PCC shared by most authors is best described as: "PCC is a mixture of technical skills and health care providers' attitude that helps elicit the patients' perspective" (1–3). To involve patients in health care decision-making, their view on, for example, the underlying problem and possible therapeutic approaches are essential (2).

For many years now, communication skills training (CST) has become a standard element of HCP student education (4–6). However, it is well established that transfer from pre-practice training to clinical practice, from continuing education seminars to real life (7, 8), or from institution-wide approaches to individual behavior (9) is challenging. CSTs have generally yielded mixed results.

Different approaches are used in implementing CST: a recent initiative in Denmark (10, 11) delivered a CST using an institution-wide approach. This demonstrated that mandatory inter-professional training was feasible and improved self-perceived efficacy in the use of professional communications techniques. An accompanying editorial (9) recommended that future research should include patient perspectives in evaluating such an inter-professional training program. An American study from Iowa (12) showed that inter-professional CST plus individualized coaching improved patient satisfaction with communication and participants' confidence in using newly acquired skills.

Communication skills training in settings for patients with spinal cord injury/ disorder (SCI/D) was largely ineffective (13–15), but some elements such as explicitly structuring an encounter and structured delivery of information showed positive results. In addition, CST has been shown to be time-efficient while improving the patient's satisfaction with communication and trustworthiness of the professionals (16–24).

Effective communication is essential in acute and rehabilitation services for people with SCI/D. These people are in extremely challenging situations: their future prospects have changed fundamentally and they have to develop a completely new body image (25). They must adapt to significant changes in the sensorimotor and autonomous nervous system function (26). Patients with chronic SCI/D suffer from difficult-to-treat pain, spasticity, and depression (27, 28). In the systematic review by Oliveira et al. who examined the effectiveness of CST and clinical outcomes of patients (13), the following critical topics were identified: (1) access to information; (2) participation in the planning of their rehabilitation; (3) emotional support; (4) feelings of vulnerability; (5) adjustment to a new life situation; and (6) emotional consequences of the injury.

To address these topics effectively, HCP need a patient-centered approach to communication. In the primary care context, this has been described as "inviting the patient's perspective" (17). In the context of SCI/D, this provides an opportunity to acknowledge patient's needs, engage people with SCI/D in self-care management, facilitate them to develop a sense of autonomy, and enhance decision-making capacity to enable better rehabilitation outcomes and higher lifelong satisfaction (29). HCP who wish to support patients in their struggle for a new equilibrium must acknowledge that patients with a long-standing chronic condition have specific knowledge about their resources, needs, and desires. By integrating their expertise with professionals' clinical abilities shared through appropriate communication techniques, the critical topics and challenges previously mentioned can be addressed. CST plays an important part in building the capacity of the SCI/D workforce to do this.

When setting up a CST in this clinical setting, the unique characteristics of a rehabilitation clinic should be considered. HCP and patients with SCI/D work together over a long period of time, often lasting more than half a year. During this time, they must come to terms with acute SCI/D-related complications, such as pressure injuries and problems with

bladder and bowel management. This is in stark contrast to a more common hospital setting, where acute problems are treated within a few days. In such an environment, professionals do not need to build a lasting relationship with patients and relatives; rather, the achievement of long-term goals takes place outside the hospital and in an outpatient setting. In a rehabilitation setting, many professional groups cooperate to help patients adapt and improve their well-being and functioning; this requires extensive inter-professional communication, e.g., between nurses, occupational therapists, physiotherapists, psychologists, social workers, physicians from different specialties, peer patients, etc. (30). Thus, in chronic health conditions, communication must acknowledge the fact that the pre-existing normality is no longer present and new normality must be developed (2, 13, 31, 32), culminating in the task of living a new life. During initial rehabilitation, patients need support in their attempt to form a new self that aligns with their capabilities and handicaps (25, 32). HCPs should be prepared to accompany individual patients on a long journey in which professional input and patients' subjective meaning ideally work together to create a new reality.

This study aimed to investigate the impact of site-specific inter-professional small-group CST on satisfaction with communication in people with SCI/D. It was also interesting to see if such training was equally well accepted by different professional groups; therefore, participant feedback was used as a secondary outcome.

Materials and methods

Design

Retrospective observational study using regularly administered participant feedback and patient satisfaction surveys in a single rehabilitation clinic. The study was conducted as an institution-wide intervention and was part of a quality improvement project. The Ethics Committee Northwest and Central Switzerland (EKNZ) confirmed that the research project met the general and scientific standard for research involving human subjects (AO_2022-0017). The reporting of the study followed the STROBE criteria (Supplementary Appendix Table 1).

Setting

This project took place in a comprehensive tertiary rehabilitation center (Swiss Paraplegic Center; SPC) that specialized in the treatment of people with an acute or chronic SCI/D. The clinic had 160 beds for the acute care and rehabilitation of patients with SCI/D, including an intensive care unit with eight beds. In 2021, the clinic employed about 1,500 people, the staff of those who have regular patient contact consisted of about 70 physicians, 300 nurses, 49 physiotherapists, and 31 occupational therapists. Since the clinic's founding in 1990, it had implemented a "holistic" treatment approach that combined inter-professional teams, spinal cord injury research, post-graduate training, a sports facility, and technical support for the specific needs of people with SCI/D. Since 2006, the clinic had used the International Classification of Functioning Disability and Health (ICF) to define rehabilitation goals and barriers within a bio-psycho-social model. As part of the continuous education of HCP, the clinic offered mandatory advanced life support courses and various voluntary courses on non-violent communication, leadership, and how to create a living will. Apart from the required quality criteria for SW!SS REHA or ISO 9002 certification, there were no specific communication guidelines or concepts.

The project started in 2014 when the hospital's administrative board decided to respond to unsatisfactory feedback from patients on various aspects of communication. To identify "hot spots" where changes in attitudes or structural deficits were likely to improve communication, the administrative board invited a well-known Swiss clinical communication expert (WL) to perform a situation analysis. Instead of standardized questionnaires or observation grids, he proposed "shadowing" members of different professional teams and observing their communication in different clinical situations. A report described his observations during ward rounds, inter-professional meetings with patients and relatives, and team meetings. This report included observations at the structural level, such as the professionals were not properly introduced during activity assessments, the role of a moderator was not defined, and the patient perspective was not systematically elicited. Similarly, during the ward-rounds patients were not systematically invited to contribute to the definition of short-term treatment goals, their emotions were sometimes ignored, etc. Information was not checked for correct understanding, and the technique of "teach back" was scarce. In general, observations revealed low patient and relative engagement in inter-professional rounds and an apparent lack of shared understanding of the patient's situation. This report substantiated the critical feedback from patients and relatives (situational report Appendix confidential). It was discussed by the hospital's administrative board, which decided in 2015 to implement CST that would address these issues.

At the institutional level, a steering committee was established that included representatives from all medical disciplines and professions. It met four to six times a year, supervised the progress of implementation and reported it to the head manager. The first step was to develop an institutional concept, which was discussed and approved by all different professional groups. Access to training, intensity and frequency

TABLE 1 Critical incident reports of prototypical constructed "cases."

Case information	Verbatim dialog	Communication challenge(s)	Communication technique
60 years old patient, had been able to walk short distances, now severe decubitus, amputation. HCP reported the therapeutic alliance had broken, unable to restore it	HCP: "Could perhaps your husband make some photographs of your flat to help planning?" Pat: "You seem to be quite sure that I will never be able to use my crutches again? You gave up on me!" HCP: "Much to the contrary, but we must adjust the floor surface"	Responding to emotions	Naming emotion
52 years old patient, respiratory distress, known lung cancer, now suspected relapse in x-ray	HCP: "I just wanted to inform you: we suspect a relapse of your cancer and would like to initiate some more examinations." Pat: [Crying. Mute. Turns his head] "I don't want to talk about it." HCP: "Then, take your time, I'll be back tomorrow and we will have another look"	Breaking Bad News HCP sets agenda without patient agreement	Warning shot, pausing
35 years old patient, first admission after accident-related complete paraplegia	HCP: "I am the new resident in here. I am going to treat you from now on. You should tell me how you are doing." Pat: "I don't want to talk to you. There's always a new doctor showing up" HCP: "As I said I am the new resident. I am here to treat you. You should tell me how you are doing."	Responding to emotions	Naming emotion Shared agenda setting
53 years old patient, tetraplegic after an operation, first admission to rehabilitation, unclear situation on a ward round, hcp felt she had done everything right (responding to emotion)	Pat: "I don't know whether I shall manage to stay in here." HCP: "I see your pain. Plus being separated from your family. And yet, you're here…" Pat: "I don't know whether I will manage…" HCP: "So, what keeps you here"	Unclear situation: what is the patient referring to? Naming emotion without waiting for the patient to respond	Space-opening techniques Naming emotion plus pause
28 years old patient attending pain service with husband	Husband: "She's still in pain. They always said 'nobody must be in pain!'. That's incredibly frustrating!" Pat: [says nothing] HCP: "I see you are angry. This kind of pain is difficult to treat. We must try several different therapies" Husband: "I'm pissed of!!!"	Responding to emotions Naming emotion without waiting for the patient to respond "Emo"	Naming emotion plus pause

of training, number of participants, etc. were defined, and training materials were adapted to the different training formats. The information of the staff about the intervention, the sending of invitation and reminder e-mails, and the collection of feedback data were taken over by the leader of the steering committee (PL, AS-S) and the human resources department.

Target population and recruitment

According to the institutional communication concept, all HCP who were senior members of inter-professional teams with direct patient contact were invited to participate. The recruitment process was mandatory for certain professional groups, mainly senior members of different professional groups. Team-specific workload and flexibility were considered to ensure continuous participation throughout the whole observation period. Overall, staff turnover rates had been comparably low with 9.4% in 2015, 8.1% in 2016, and 11.3% in 2021 (numbers provided by the human resources department). Attrition differed by participant status: while almost all senior team members retained their role during the observation period, junior doctors spent between 1 and 2 years as residents before moving to another training hospital.

The annual surveys were part of routine quality assurance, and discharged patients could choose whether or not to complete these surveys as volunteers. Data for this study were extracted from standard MECON items. These surveys were financed by the hospital and sent by a neutral and official organization (MECON). These surveys included general

questions about satisfaction with care, organization, and communication. No reference to this CST was mentioned.

Intervention: The communication skills training

The CST is based on a well-established CST of the University Hospital Basel (9, 33–35) in inter-professional small-group training. The author of the seminar material (WL) agreed to provide the clinic with all relevant materials for its own use.

After the AS-S attended a 2.5-day "train the trainer" seminar at another institution ("train the trainer" manuals are available upon request from the last author) led by WL, AS-S and WL held the seminars together. They lasted 8 h and included between 8 and 12 participants. A refresher course was offered about 2 years after the initial seminar; it lasted 4 h and focused on problems participants had encountered in applying newly acquired communication skills.

The seminars started with explicit information about the agenda and time structure. Confidentiality issues were addressed at the beginning of each seminar, and the content of the seminar was covered by the rules of medical confidentiality that apply to all hospital employees and are part of their contract. Individuals mentioned in critical incident reports were not referred to by their real names and were described in as little detail as possible. Waiting, echoing, mirroring, and summarizing (36, 37) were employed as space-opening techniques. In particular, the topic of attentive listening stimulated discussion of cultural issues: how long is appropriate to pause with a constant gaze on another person is largely a culture- (and sometimes gender-) specific issue. Explicit structuring was presented in terms of communicating a time frame, agreeing on the agenda, and providing information about the structure of a consultation or a meeting (21, 22). Gender issues came into play here, as young female participants, in particular, recognized that explicitly setting the agenda could serve to establish themselves as responsible for the course of an interaction. The role-playing sessions were brief, typically lasting <2 min. This allowed tutors to give a rapid and concrete feedback that ideally motivated the role-play interactants to "give it another try." The tutor's feedback was particularly attuned to creating or maintaining a "playful attitude" (38), demonstrating that successful communication never follows strict rules, but rather is the result of a trial-and-error process that is based on some basic underlying principles (39). During the seminar, prompt videos were shown to stimulate discussion about participants' ability to assess another person's emotions. From participants' widely varying assessments, it appeared that identifying an emotion in another person is at best an educated guess and therefore should be taken as a suggestion rather than affirmative diagnostic labeling. The task of "breaking bad news" was illustrated with movie clips that show different types of suboptimal performance. It is evident that the seminars were enriched using different types of didactic material (40–42).

"Critical Incident Protocols" (CIP) were used, linking participants' everyday experiences of difficult communication to the content of the seminar. After participants completed their CIP (which took approximately 10 min), the following three-step procedure was applied (Supplementary Appendix Data Sheet 3 Table 1):

1. Produce shortened verbatim protocols of participant CIPs on flip-chart.
2. Identify teachable moments (43) that help to illustrate the use of a certain communication technique (Table 1).
3. Apply communication techniques in role-play sessions between participants based on the respective CIP.

Depending on the professional background, critical incidents referred to communication with patients or relatives or with other professionals. Table 1 lists examples of CIP from HCP with different professional backgrounds. To maintain confidentiality, we do not report original CIP but construct prototypical "cases" from various protocols.

The seminars offered a combination of learner-centered elements (starting from problem cases of the participants) and trainer-centered inputs (information segments on communication techniques and facilitation during role-plays) that mimic encounters between patients and HCP. Exactly the same elements can be found in daily clinical management: listening to the patient's perspective, sharing information, and accompanying patients and relatives in the rehabilitation process.

The format of the on-the-job feedback was not strictly defined: some participants requested feedback on a specific skill they wanted to use, and others were interested "in anything you find interesting to me." AS-S and WL shared their observations and decided whether to bring the topics to the steering committee. When the results of the on-the-job feedback were discussed outside the trainer dyad, neither the names nor the working place of the participants was mentioned.

Implementation

Participation in the CST was voluntary in the first year (2015) to assess the feasibility and acceptance of the intervention. When feedback from participants was positive, the steering committee discussed whether participation should become mandatory and decided against this option. However, in two cases, the courses were mandatory: first, when a professional group (primarily senior consultants and senior physiotherapists) decided on its own initiative that all of its members should attend a seminar, this was accepted by the steering committee.

Second, when participants developed communication standards within their professional group (e.g. activity assessments in an inter-professional setting; organization of ward-rounds between nurses and physicians; a standard procedure for peer patients, etc.), these standards became mandatory after thorough discussions and acceptance by the steering committee and among the professional groups involved.

Data collection and presentation

Implementation data were collected using the institutional data provided to the steering committee, including the number of training, the number of participants, and the time invested.

The CST sessions were evaluated by the HCP using a questionnaire developed by the human resources department for evaluating seminars (Supplementary Appendix Data Sheet 2). It was approved by the steering committee and distributed *via* e-mail a couple of days after the training.

Patient satisfaction was assessed using a standard survey provided by an external company (MECON measure and consult GmbH; Supplementary Appendix Data Sheet 1). The survey was sent home to all patients after discharge and it measured different aspects of patient feedback on the overall quality of care, communication with professionals, quality of coordination among hospital staff and units, and non-medical service on a 5-point Likert scale (1 = not at all satisfied; 5 = completely satisfied). Results are presented as index values on a scale of 0 to 100 and as the arithmetic mean of the maximum percentage score with confidence intervals (CI). We performed a linear regression analysis to test for significant changes over time.

Results

Number of trainings and evaluation

During the observation period between 2015 and 2020, 15 basic training sessions and 16 refresher courses were conducted. In addition, five short training sessions with a specific focus (anesthesiologist and presurgical information) were organized. One "train the trainer" course was conducted in 2019 with the goal of training steering committee members to become communication trainers. These eight participants, mainly members of the communication steering committee, were recruited at least 2 years after their participation in the actual CST.

In 2015 and 2021, the clinic employed 1,142 and 1,445 HCP, respectively. A total of 262 employees participated in one of the training sessions: 161 participants in the basic training, 84 participants in the refresher training sessions, and 17 participants in the short training sessions (Table 2). Participants were 69 residents and medical students in their final year of training, 36 senior physicians (specialized in paraplegia, urology, orthopedics, and neurology), 63 nurses, and 36 physio-, occupational- and nutritional therapists with leadership roles, 12 psychologists, seven social worker, and six vocational counselors. Of these, 20 participated twice.

The time investment between 2015 and 2020 can be calculated as the sum of participation time (161 full-day seminars of 8.5 hours each) plus 84 half-day seminars of 4 h each, plus steering committee meetings. A total of 250.4 days were spent by participants, 47 days by two trainers (WL, ASS), and 12 days on on-the-job training (Table 2). A total of 268 h were spent in 25 steering committee meetings lasting about 90 min each with five to eight members (Table 2).

Evaluation of communication training: Participants and patients

Overall, 37.6% (92/262 participants) provided structured feedback, 38.5% (62/161 participants) in the basic training, and 35.7% (30/84 participants) in the refresher courses. The distribution between theory, discussion, and practical exercise was rated positively by 91.3 % of participants in both the basic training sessions (88.7%) and the refresher courses (96.7%). The duration of the trainings was rated as ideal by 80.2% (basic 77%, refresher 86.7%). The professional competence was rated as absolutely competent and practical 90.1% (basic 93.4%, refresher 83.3%). Approximately, 32.2% of participants responded that they achieved all learning goals (basic 35%, refresher 26.7%) or the greater part of their learning goals, 52.2% (basic 48.3%, refresher 60%). They rated the content extremely positive and were determined to apply it, 38.6% (basic 40%, refresher 35.7%), or motivated to apply it, 44.3% (basic 38.3%, refresher 57.1%). The participants responded that the quality of their work had noticeably improved, 44.7% (basic 41.4%, refresher 51.9%), and that they could recommend the seminar to others, 98.8% (basic 98.2%, refresher 100%). A few participants gave negative feedback concerning the duration being too short, 16.5%, or too long, 3.3%, not achieving the learning goals, 1.1%, the content, 1.1%, lack of motivation to apply the content, 1.1%, or the insecurity in applying the newly acquired tasks, 3.5% (basic 3.4%, refresher 3.5%) (Supplementary Appendix Data Sheet 3 Table 3).

Patients' satisfaction

Standard surveys (MECON) yielded the following results (scores normalized to a 0–100 scale): in 2014, patients rated "satisfaction in general"with 83.1% (CI 2.6%), "receiving information" with 81.1% (CI 3.1%), "being able to bring in concerns" with 83.0% (CI 3.1%), and "being treated with

TABLE 2 Time invested for education in different professions.

	2015	2016			2017			2018			2019		2020	
	3x Bas	3x Bas	1x Ref	1x Sh Tr	2x Bas	4x Ref	2x Sh Tr	2x Bas	3x Ref	2x Sh Tr	3x Bas	4x Ref	2x Bas	4x Ref
Trainer *n* (d)	2 (6)	2 (6)	2 (1)	2 (0.5)	2 (4)	2 (4)	2 (1)	2 (4)	2 (1.5)	2 (1)	2 (6)	2 (4)	2 (4)	2 (4)
Participant *n* (d)	27 (27)	36 (36)	4 (2)	4 (1)	21 (21)	27 (13.5)	6 (1.5)	25 (25)	11 (5.5)	7 (1.75)	35 (35)	19 (9.5)	17 (17)	23 (11.5)
Senior physician *n*	6	6	–	3	2	3	1	3	2	–	4	2	2	2
Residents/ medical students *n*	7	4	–	1	2	9	5	4	2	3	7	8	5	12
Nurse *n*	14	9	–	–	3	13	–	6	2	–	5	4	4	3
Physio–, occupational– and nutrition therapist *n*	–	6	–	–	3	–	–	9	4	–	5	2	4	3
Psychologist *n*	–	5	–	–	1	–	–	1	–	4	1	–	–	–
Social worker *n*	–	–	–	–	2	–	–	1	–	–	3	–	1	–
Vocational counselor *n*	–	–	–	–	1	–	–	–	–	–	4	1	–	–
Peer counselor *n*	–	–	–	–	4	–	–	–	–	–	–	1	–	–
Rehab coordinators *n*	–	4	3	–	1	2	–	–	–	–	1	1	1	2
Others *n**	–	2	1	–	2	–	–	1	1	–	5	–	–	1
Constitutional meetings *n* (h ⩓ d)						56 (80 ⩓ 10)			62 (78 ⩓ 9.75)		48 (72 ⩓ 9)		26 (39 ⩓ 4.9)	
Training on the job *n* (d)						1 (2.5)			1 (2.5)		1 (2.5)		1 (2)	
Time invest overall (d)	(33)		(46.5)			(57.5)			(51)		(66)		(43.4)	

Bas, Basic Training (full day seminars à 8.5 h); Ref, Refresher (half-day seminars à 4 h); Sh Tr, Short Training; n, number; d, number of working days; h, hours; *others, process group leader, research assistant, leader human resources, patient care service, quality management, corporate communications.

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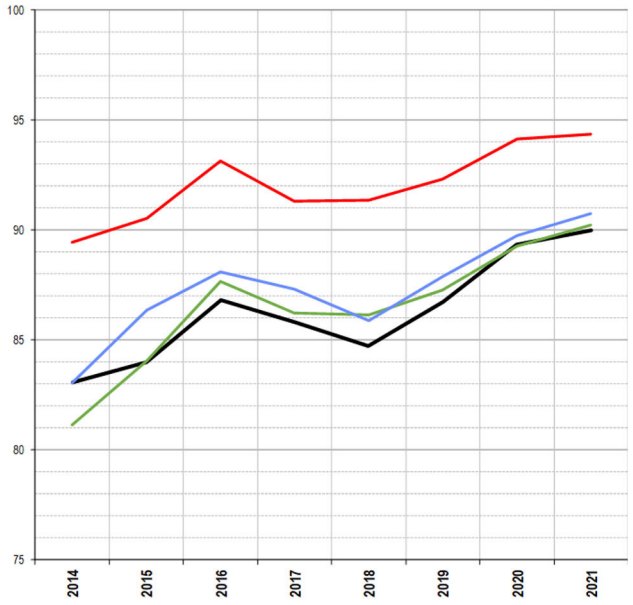

		Sat.-index	90%-IC	Number
2021	**Satisfaction overall**	90.0	0.8	567
2020	Satisfaction overall	89.3	1.1	353
2019	Satisfaction overall	86.7	1.2	441
2018	Satisfaction overall	84.7	1.2	410
2017	Satisfaction overall	85.8	1.0	478
2016	Satisfaction overall	86.8	1.1	410
2015	Satisfaction overall	84.0	1.2	418
2014	Satisfaction overall	83.1	2.6	98
2021	Information complete	90.2	1.0	563
2020	Information complete	89.3	1.3	348
2019	Information complete	87.2	1.3	435
2018	Information complete	86.1	1.4	405
2017	Information complete	86.2	1.2	473
2016	Information complete	87.6	1.2	407
2015	Information complete	84.1	1.4	417
2014	Information complete	81.1	3.1	98
2021	Be able to bring in concerns	90.8	1.0	551
2020	Be able to bring in concerns	89.7	1.3	344
2019	Be able to bring in concerns	87.9	1.3	433
2018	Be able to bring in concerns	85.9	1.4	398
2017	Be able to bring in concerns	87.3	1.3	468
2016	Be able to bring in concerns	88.1	1.3	402
2015	Be able to bring in concerns	86.4	1.3	412
2014	Be able to bring in concerns	83.0	3.1	98
2021	Respect and dignity	94.4	0.8	558
2020	Respect and dignity	94.1	1.0	346
2019	Respect and dignity	92.3	1.1	433
2018	Respect and dignity	91.3	1.2	403
2017	Respect and dignity	91.3	1.1	471
2016	Respect and dignity	93.1	1.1	404
2015	Respect and dignity	90.5	1.2	413
2014	Respect and dignity	89.4	2.6	95

Sat.-index = Satisfaction index
(100 = max. satisfaction ; 0 = min. satisfaction)
IC = Interval of confidence

FIGURE 1
Patients' satisfaction measured with an institution-specific questionnaire of an independent institute (MECON).

respect" with 89.4% (CI 2.6%) (MECON data; Figure 1). In 2021, satisfaction ratings had increased for "satisfaction in general" to 90% (CI 0.8%; $R^2 = 0.776$; $p = 0.004$), for "receiving information" to 90.2% (CI 1.0%; $R^2 = 0.798$; $p = 0.003$). Satisfaction with "being able to bring in concerns" had increased to 90.8% (CI 1.0%; $R^2 = 0.707$; $p = 0.009$) and "being treated with respect and dignity" to 94.4% (CI 4.8%; $R^2 = 0.708$; $p = 0.004$) (Figure 1). Annual data are displayed in Figure 1. In 2017, 2018, and 2019, satisfaction ratings had gone down reflecting changes in institutional organization and problems with the recruitment of residents resulting in a low coverage of doctors' presence on wards. However, during the whole observation period, annual satisfaction scores were higher than the pre-intervention numbers in 2014 (Figure 1).

Additional effects of the communication skills training

Based on the experts' feedback, different professional groups started refining their clinical practice: nurses and physicians developed a standard procedure for clinical ward-rounds, and inter-professional group of therapists, nurses, peer patients, and physicians developed a new standard for the assessment of patient activities (Supplementary Appendix Data Sheet 4). In applying these standards, participants received specific feedback on the job that helped them achieve their goals. To sustain these changes, annotated training videos were produced to demonstrate best clinical practice; an introductory video was installed for new team members to provide an overview of institution-wide principles of patient-centered communication.

In the course of the intervention, word spread that communication was an issue at the institution and that discussing communication issues with the expert had helped others. This encouraged other professionals to ask for support with their specific communication challenges. Usually, a representative of the respective group reached out to AS-S. Specific training sessions with a well-defined focus were developed for some of these employees who had not been invited to participate in the CST initially. For example, hotel service staff argued that they also had patient contact and would therefore benefit from specific training. Secretarial staff at the outpatient reception desk wanted support in dealing with demanding patients or relatives. Peer counselors wanted coaching on their self-awareness, culminating in a standard for presentation to in-house patients. Specialized seminars were also offered to the facility services team, the intensive care unit nursing team, and the psychology team, and the outpatient clinic administrative team requested additional meetings.

Therapists, nurses, and physicians suggested producing educational videos on good communication practices to be shown to new team members or to use in in-house presentations or at professional meetings.

Discussion

Implementation and adaptation

We report 6 years of experience with an inter-professional small-group CST. It proved feasible and acceptable and had a positive impact on patients' evaluation of service experience in each year of implementation and HCP's evaluation of learning experiences. It required coordination by experts at multiple levels, structural coordination by a steering committee, and the use of institutional data already collected for workforce reporting, patient satisfaction and staff planning. The program was embedded in an institutional environment that supported in-house continuous professional development through release time, "train the trainer" opportunities, investment in specialist expertise, alignment with institutional quality system goals, and access to institutional data on staff and patients.

Participant feedback showed that the intervention was useful in daily practice and provided a balance between learner-centered principles and tutor input and between practice and theory. Patient surveys showed a sustained positive effect on the perceived quality of communication.

Since we did not compare different means of implementing the communication skills intervention, we rely on informal comments from participants and stakeholders. We believe that the following aspects were important for the success of the implementation process.

The credibility of the intervention improved by the fact that it was initiated by data from an independent and trusted organization outside the institution.

When this external source-reported deficits in patient satisfaction with communication the hospital's administrative board decided to commit to an institution-wide effort to invest in these critical domains. Besides in-house capacities [continuous professional development (44)], support from an authoritative institution (the University of Basel) was invited.

The format of CST and feedback on-the-job was flexible, thus responsive to the emerging needs of clinic members during the course of the intervention.

Although different training formats required a different balance of these elements, the explicit pedagogy remained the same: rapid-cycle deliberate feedback, participant-generated CIP, and a confidential small-group environment. We assume that the use of CIP helped to ensure practicality, participant problems were addressed rather than problems derived from the literature (20). The use of CIP in seminars stimulated active participation and helped to link communication theory and practice directly to rehabilitation scenarios. Skills relevant to inter-professional collaboration (45–47) became evident as participants from different professional groups interacted and role-played different communication strategies.

On-the-job feedback allowed tutors to see learners in action and gain insight into the feasibility of learning objectives in a clinical context.

Lessons learned

It takes a long breath to change the culture within an institution and to realize the benefits of such an institution-wide approach. Resistance was a common phenomenon, especially in the early stages. Mutual support among tutors and within the steering committee helped to keep on going, remain calm and keep a positive stance, and remain humble even in the face of reluctant or dismissive colleagues (45), that is, to "practice what you teach" (44).

Limitations

Since this observational study targeted representatives of many professional groups and was open to new professional groups if they requested training themselves, a structured situational analysis of communication skills and inter-professional communication culture was not possible.

Another critical point is the low response rate to the feedback questionnaire. This may have introduced bias in that more satisfied patients were more likely to take the time to indicate their satisfaction with various aspects of their hospital stay. However, even if that were the case, it would be a systematic error, which applies to all data points in the time series of observations. In general, data show that satisfaction surveys are sensitive to changes in the hospital environment, as suggested by Otani et al. (48, 49): the dip in 2017 and 2018 was most likely due to a dramatic shortage in staff, mainly on the residents' side, and sometimes it proved difficult to assign one resident per ward.

Apparently, participants perceived tutors as trustworthy. This might limit the transfer from our intervention to other settings. We assume that the credibility of tutors was supported by their clinical and theoretical expertise (a rehabilitation specialist and a communication expert and clinician). We are aware that working with CIPs requires an enormous flexibility from the tutors. They were never sure, which mix of problems would be presented during a seminar and had to adapt "on the fly" to the needs of the participants. This was the main reason why participants

in the "train the trainer" course did not feel competent enough to conduct courses in a similar manner. Future developments should probably take these high demands into account and consider a slightly modified approach to conducting seminars.

A fundamental criticism might relate to the lack of behavioral measures for improved communication competence. As we argued in an editorial on articles describing interventions in the field of "breaking bad news," (50) there is ample evidence that training sessions do their job. We have no reason to assume that the training we applied would be less efficient than other training sessions. However, even when communication is technically improving, patients rarely benefit (16) as shown in a well-designed study with long-term follow-up of patients and relatives. In our study, we therefore took the evaluation one step further and assessed patient satisfaction with communication as the primary outcome, which we consider a major strength of the intervention.

Strengths

In contrast to recent intervention studies, we did not report changes only in the group of "extremely satisfied" patients (24). Instead, we report average scores that include all patients, which renders our results more relevant. After 2017 and 2018, characterized by a shortage of residents, the clinic's reputation apparently improved, and more young doctors applied for a position at the hospital. In 2021 the clinic was awarded "Best employer among Swiss Rehabilitation Hospitals."

Summary

Small-group, site-specific inter-professional CST in the acute care and rehabilitation context was feasible, and it made a difference for patients who attested to improved communication in patient satisfaction surveys. Integration in an institutional-wide change process, supported by the administrative board and participants' centered training sessions combined with feedback-on-the-job, seem to be factors for success.

Data availability statement

Participant training feedback data are stored with the corresponding author in institutional records in a clinical medium. Anonymized patient satisfaction surveys are stored at MECON [www.mecon.ch]; as company data they are not available. MECON agreed to have the dataset published. The critical incident protocols were deleted following data analysis in accord with the ethic approval.

Ethics statement

The studies involving human participants were reviewed and approved by Ethical Committee North West Switzerland (EKNZ AO_2022-00017). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

AS-S, WL, PL, and DS-N were responsible for the implementation of the intervention. AS-S, SE, MS, and WL performed data analysis. MS performed the statistical analyses of the patient survey data. LJ and DS-N supported the intervention as representatives of the management board and guaranteed institutional integrity. AS-S, SE, and WL wrote the first draft. All authors made substantial contributions to study conception, data collection, interpretation of results, gave critical feedback to several versions of the manuscript, read, and approved the final version.

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Conflict of interest

Author MS was employed by MECON Measure and Consult GmbH.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors of the study were also engaged in the steering committee of the intervention. Even when the results (participants feedback and patients surveys) are independent of the authors the presentation of the study might be biased.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fresc.2022.883138/full#supplementary-material

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Building PRM in sub-Saharan Africa

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It is estimated that about 50% of people in low- and middle- income countries who require rehabilitation do not get it. Multidisciplinary rehabilitation services led by Physical and Rehabilitation Medicine (PRM) physicians have been shown to improve functioning, independence and the quality of life of persons with reduced functioning or disability. However, there is a dearth of PRM physicians in low to middle income countries (LMICs), particularly in sub-Saharan Africa. One potential solution to this lack of specialists is the establishment of PRM training programs, which are currently lacking. The International Rehabilitation Forum (IRF) developed and implemented a fellowship program to train physicians in rehabilitation medicine and has been successful in Ghana, Ethiopia and Cameroon, all LMICs in sub-Saharan Africa. However, ongoing challenges include inadequate PRM trainers, availability of logistics and services for hands on experience, and funding. The fellowship program has a promising future and an ultimate goal of having locally trained fellows leading the program and expanding it to other LMICs. There has however been no publication of the process followed to achieve this or of a similar process undertaken anywhere in Africa. The process followed in this publication highlights the journey from engaging stakeholders to the admission of new and current fellows in training.

KEYWORDS

physical and rehabilitation medicine, fellowship program, curriculum, training, Sub-Saharan Africa, Ghana

Introduction

There is an increasing unmet need for rehabilitation globally. The WHO estimates that about 50% of people do not receive the rehabilitation they require (1). This need is particularly high in low- and middle- income countries (LMICs) including those in sub-Saharan Africa. The reasons for a high percentage of unmet rehabilitation needs are multifactorial. One reason is rising non-communicable diseases in LMICs which are often associated with complications leading to disabilities (2). This is partly due to the negative culture of poor health screening. The quality of healthcare is also improving in these countries so the ageing population is increasing with its resultant

reduction in functioning (3). Lastly, a high rate of road traffic accidents partly from poorly constructed roads is resulting in disabilities (4).

One strategy for addressing rehabilitation needs in high-income countries is for rehabilitation to be provided by a multidisciplinary team of rehabilitation professionals including occupational, physical, speech and language therapists, orthotists and prosthetists as well as rehabilitation nurses all led by a PRM physician. This approach to care has been shown to improve functioning, independence and the quality of life of persons with disabilities or reduced functioning (5). With the exception of the northern African countries of Morocco, Tunisia and Algeria, there is a dearth of PRM physicians in many countries in Africa including sub-Saharan Africa where the few PRM physicians are found in French speaking countries and mostly have partnerships with France for their training programs (6).

The establishment of PRM training programs in sub-Saharan Africa plays a very important role in increasing the number of PRM physicians and thus improving access to care. However, PRM training programs are lacking in a huge part of sub-Saharan Africa. A study published by Haig et al in 2009 revealed that there were only six PRM physicians in the whole of sub-Sharan Africa and this did not include Ghana (7).

The lack of PRM physicians meant that persons with reduced functioning missed out on comprehensive and coordinated rehabilitation in majority of sub-Saharan African countries where disability is stigmatized. This resulted in persons with disabilities being abandoned by family or ending up on the streets begging for alms to survive.

This paper chronicles the development of PRM as an important and vital specialty in sub-Saharan Africa using Ghana as a case study. The paper highlights the successes and challenges to improving access to PRM care through the establishment of a training program while providing recommendations for building on this approach.

Method

Bridging the gap

In response to the shortage of PRM providers and lack of medical rehabilitative care in LMICs including those in sub-Saharan Africa, the International Rehabilitation Forum (IRF), a non-for-profit organization, was created in 2009 by American and international rehabilitation advocates. The purpose of IRF is to build relevant rehabilitation medicine practices in low-resource and isolated regions.

The IRF utilized grass roots efforts and disruptive innovation as a means to challenge the status quo of rehabilitation in low resource settings. Examples of these efforts include identifying and mentoring rising leaders in LMICs, researching and publishing on disability policy, creating and distributing free videos on disability, and hosting "world congresses" in LMICs to foster local partnership (8). More recently, though COVID-19 largely prevented in person gatherings, the IRF held cost-free virtual global conferences during the pandemic. Over 60 PRM professionals from 25 countries joined the virtual conferences to discuss building sustainable rehabilitation programs in low resource settings, promoting physiatry to medical school students, and creating global rehabilitation curriculums. While many ministries of health in LMICs recognize a need for improved rehabilitation, there is often a lack in domestic resources needed to build programs (9–11).

To help address resource needs in sub-Saharan Africa, the IRF developed a plan to for a PRM fellowship training program utilizing international resources from high-income countries. In this case, the predominant resource utilized was teaching personnel for education. International educators dedicated their time to train interested physicians in sub-Saharan countries to become PRM experts and help construct sustainable programs. This model of international partnership between high-income and LMICs has been described by other medical specialties as well (12, 13).

The development of a fellowship program was based on a decade of exploration and trials. First explorations revealed a shocking lack of PRM specialists, formalized in an article that found only six specialists in all of sub-Saharan Africa. This article, which exposed failures of health systems, governments, non-government organizations and the WHO; was published simultaneously by five international journals as a call for action (7, 14–17).

To develop a strong and sustainable program it was important for the team to understand the socio-political environment, build more of a case for change, and get approval and support. To achieve this, African ex-patriates, including the Ghana Medical Rehabilitation Group, met monthly with IRF leaders, orienting them to culture, politics, and opportunities. There was initial fundraising to begin the program. African-born American-trained PRM specialists were identified and recruited as liaisons. Research publications co-written by African and American PRM physicians demonstrated the underrepresentation of disability in government epidemiological data (18), pointed out the inadequacy of trauma (7) and cancer (19) rehabilitation, explored Africa's need to build rehabilitation (20), and made the case for economic benefit to hospitals (21). Numerous trips identified rehabilitation supporters including neurologists, neurosurgeons, pediatricians, clinical directors of health and ministers of health in ministries and health institutions in countries. An important universal barrier was that in each country the premier government hospital was not capable or supportive of this change in healthcare.

The program only moved forward when African physicians with a passion were made aware of the IRF. A team of physicians including an Ethiopian doctor as well as the then Ethiopian minster of health and now WHO secretary general visited the United States. During that visit they met with IRF leadership and encouraged development of an on-line fellowship with a promise to approve it through the ministry of health. In Ghana, a dedicated physician associated with the IRF identified PRM could be moved forward as a 2-year subspecialty if developed as a "Sports, Exercise and Rehabilitation Medicine" program. Both countries had a very stringent, but somewhat different criteria for specialty training and a program was designed to fit both systems.

Curriculum

Currently, little is known about the best curriculum to teach PRM on a global scale. A literature search for a structured curriculum for PRM training globally or *via* distance learning yielded no results. The initial IRF fellowship program was loosely organized around the Accreditation Council for Graduate Medical Education (ACGME) core competencies and modeled after residency training programs in the United States, headquarters of the IRF. The curriculum included components of the International Society of Physical and Rehabilitation Medicine's (ISPRM) core curriculum and competencies published in 2019 (22) with adaptations to also provide PRM training on conditions common in the African setting such as clubfoot and tuberculosis of the spine. The IRF also utilized the International Classification of Functioning, Disabilities and Health (ICF) as the basic tenet underlying the training of fellows (23). This was to teach fellows to approach rehabilitation from a biopsychosocial point of view, linking a person's level of functioning to the strong interaction between their health condition, environmental factors, and personal factors. One long term goal was to not only train these physicians as experts in PRM, but also as locally trained educators to form a core teaching staff in country to sustain the program long term.

To develop a robust educational curriculum the IRF leadership recruited a fellowship director and a co-director. The framework of Kern's six step approach to curriculum development was then employed (**Figure 1**). (1) Problem identification and general needs assessment; (2) Targets needs assessment; (3) Goals and objectives; (4) Educational Strategies; (5) Implementation; and (6) Evaluation and feedback (24). Realizing that curriculum development is a dynamic process, leadership brainstormed ideas in a non-linear process, allowing thoughts and ideas to progress being ever mindful of three things: First, that all the fellows are already expert internal medicine/family physicians in their home countries and are dedicated to building on their current knowledge base to learn the specialty of PRM. Second, that in country populations and medical conditions although similar, may be different than those in the US and that resources such as equipment, access to care, medications, financial access to services and cultural norms and attitudes will influence the educational needs of trainees differently in different countries. Third, that core clinical training taking place in country will focus in part on orthopedic, sports medicine, neurologic conditions and orthotics and prosthetics and as such the goal of the didactic sessions is to instill knowledge and core thought processes based on PRM principles, establishing a "Rehabilitation mindset".

The curriculum content for year one focused on covering core subjects with year two taking a deeper dive into each subject with more focus on case-based learning and fellows own case discussions (**Figure 2**).

Once a core subject matter and principles outline was developed, the training team recruited content experts for each subject globally. The methodology for teaching included a multimedia approach. Content expert power point and video-based lectures were pre-recorded and accessible online to allow flexible access to learning modules. The online formats were standardized to a universally downloadable and viewable format to accommodate operability on multiple device platforms with consideration of potential connectivity issues. One hour live (*via* internet) weekly didactic sessions with experts reviewing core content from the lectures and facilitating discussions of application to practice occurred. Homework assignments to reinforce learning concepts or to promote exposure to rehab mindset conceptualizations were made. Additionally, an on-line discussion forum was established to bring cases and questions to both fellow learners and content experts and to share clinical scenarios. A bank of core articles and assessment scales was also made accessible *via* the internet for all learners. Pre and post-tests were performed to assess acquisition of new knowledge. The in country sponsoring institutions were ultimately responsible for clinical experiences for the learners, but specific recommendations were made by leadership for experiences the fellows should seek out such as joint injections or exposure to EMGs. In the last 6 months of training, fellows completed their dissertation research and graduated or sat for their board exams depending on their medical college's guidelines.

The development of the curriculum for the fellowship program was also structured around equipping fellows with the skills required to prepare and present on common PRM topics both to colleagues and at conferences as well. Fellows also developed skills which enabled them to teach basic PRM to medical students and allied health professionals. This skill was vital in increasing medical students' exposure to and knowledge about PRM as a medical specialty which previously was missing.

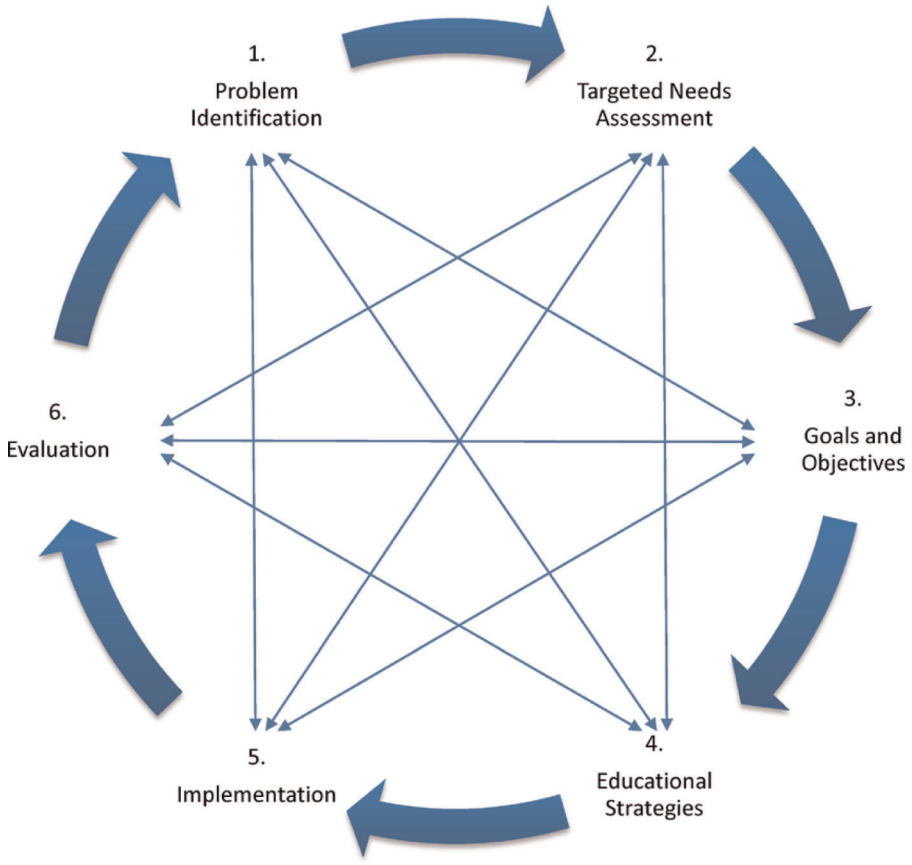

FIGURE 1
KERN cycle for medical curriculum development (24).

Results

Successes and challenges

As of this publication, the fellowship has graduated four fellows, one from Ghana and three from Ethiopia. The current fellowship includes two cohorts with cohort one including three fellows (Ghana, Ethiopia and Cameroon) and cohort two including three fellows, all from Ghana. The political process involved in the establishment of a PRM fellowship in other African countries has been challenging. Cameroon has yet to formalize the training, and as such their fellow will receive an IRF diploma without board certification of the specialty of PRM. South African colleagues intend to join the next cohort of trainees despite no formal structure under the MOH and will work to gain government recognition only after a number of graduates can advocate for their careers.

As a requirement of developing the educational program it was requested that host hospitals commit their trainees' time, have allied health and specialist physician buy-in, and establish a small inpatient rehabilitation unit. Despite promising initial conversations neither of the SSA host hospitals have made gains in establishing space for inpatient rehabilitation at this time. The opportunity to create rehabilitation wards is immediate with post operative and neurologically injured patients having long stays and future rehabilitation units providing a value-added service freeing surgical specialists and internal medicine beds and time to focus on acute needs. Without inpatient rehabilitation wards for hands on patient care experiences it is difficult to adequately train the fellows and development of functioning rehabilitation teams will be a daunting task as the fellows work to establish PRM as a specialty in their country. Once there is a core PRM trained group of providers, nurses and therapists trained in rehabilitation concepts and techniques will be necessary to appropriately treat injured and disabled patients for optimal outcomes.

Fellows have taken on the mantle of academic and political leadership in African rehabilitation. As a group they have published a number of papers on rehabilitation in Africa (6, 25, 26). They also mobilized at the beginning of the

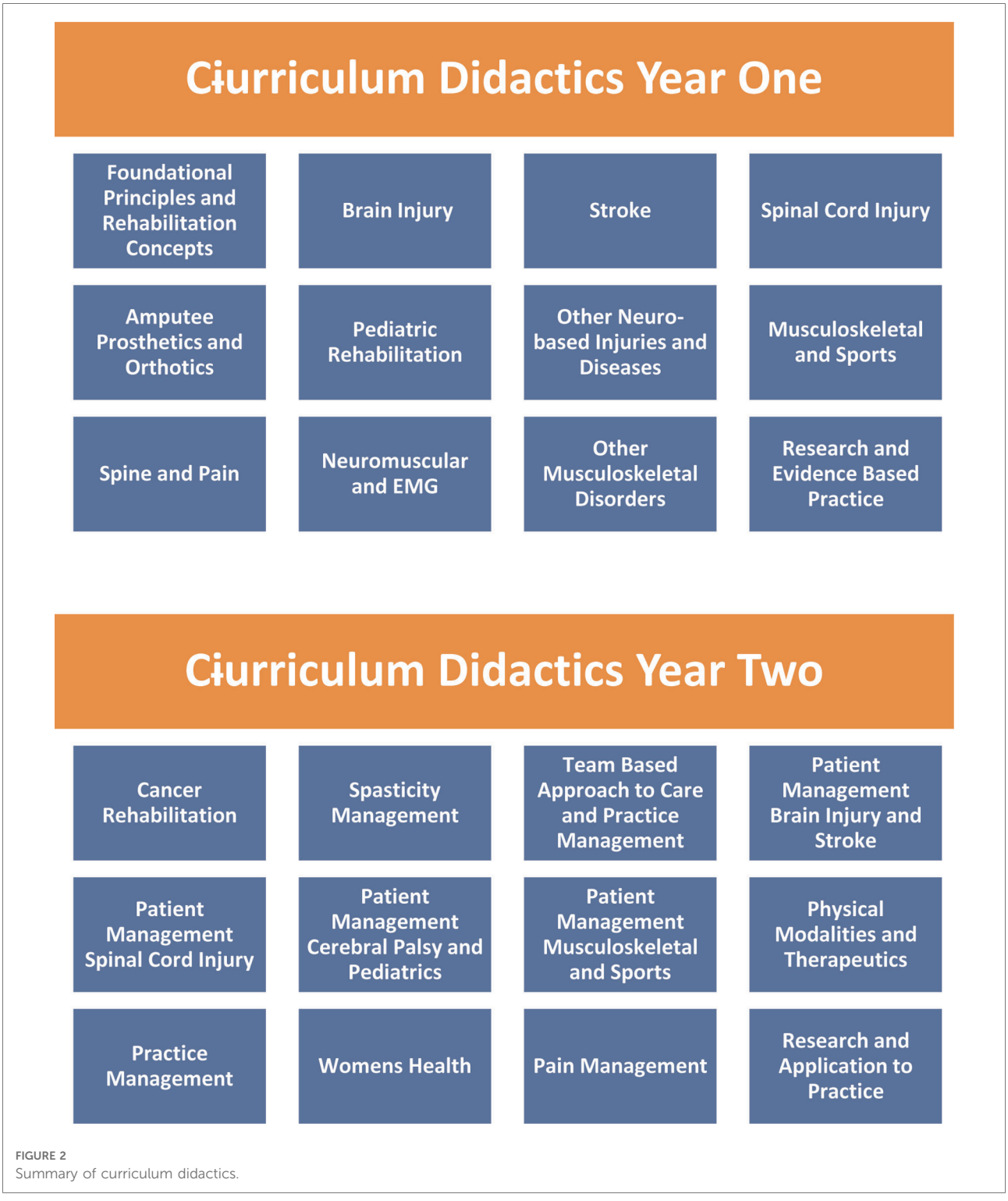

FIGURE 2
Summary of curriculum didactics.

COVID-19 pandemic to put out the very first international rehabilitation triage tools (27). Ghana's first graduate has taken important roles in the WHO, the ISPRM, and the IRF along with the role of fellowship director in Ghana. One of Ethiopia's first graduates is successfully developing an inpatient rehabilitation program and Cameroons soon to graduate fellow has formed a Cameroon rehabilitation consortium including research and education missions, while others are influencing policy through their current roles, including a family practice residency director and a leprosy

hospital medical director. These very first pioneers had passion and career-paths in mind. Each felt a need for credibility. Clinical career paths going forward appear to tie extensively to prior passion. They include neurorehabilitation, orthopedic inpatient rehabilitation, cancer rehabilitation, leprosy, pediatric rehabilitation and sports rehabilitation.

Challenges have been faced in the program running and development, with a primary obstacle being lack of adequate in country expertise in PRM and as such awareness of the field. One goal of the program is for graduates to not only practice PRM, but to also become the mentors and clinical teachers for future fellows. Until that occurs, training will continue to be led by those practicing outside the host countries.

Although an initial hope was for the program to largely be taught in country by African orthopedic surgeons, neurologists, and physiotherapists, none of these specialists had ever interacted with a doctor specializing in functioning (PRM) so the current distant-led program was chosen. Bridging this medical cultural gap is a major focus of the first 8 weeks of the fellowship. Questions of "how does a PRM consultation add to good care by a neurologist or orthopedic surgeon?" are answered with basic competency training in bowel, bladder, swallowing, nutrition, skin, and mental health. Introductions to how a PRM team functions including introduction to allied health professions, some of whom do not exist in many SSA countries is provided as is the multidisciplinary team approach to care which is a basis of PRM. Training fellows in the basic science of exercise, functioning, and outcomes is paramount to the rehabilitation mindset and without this orientation fellows risk returning to a "diagnose-treat-cure" process rather than also including functioning and quality of life in their treatment plan.

Because many allied health specialties are not universally present in SSA and others training may vary widely, education regarding the potential of these roles at times was theoretical. Providing an introduction to what different specialties, such as speech therapy, may contribute to treatment of a stroke or brain injury patient expanded long-term thinking and planning for the fellows as they develop not only their own practice but are poised to lead the profession of PRM in their own countries. The cultural aspect of rehabilitation, advanced in more mature rehabilitation systems by other team members such as nurses, recreational therapists, occupational therapists or rehabilitation counselors, appeared as new and exciting visions for health care, for the fellows, who are uniformly passionate about disability rights.

This gap between established rehabilitation and the African reality leads to a critical need for the fellows to have opportunities to learn hands on in functioning rehabilitation units and teams in observation overseas. Initial fellows who had this opportunity came home confidently advocating for sophisticated rehabilitation, having seen PRM in a mature light. More technical or hands on aspects of learning are difficult to teach without travel by either the trainee or the trainer. These include spinal injections, electrodiagnosis, neurolysis, serial casting, manual exam and other skills. The variable availability of equipment such as ultrasound machines, EMGs, fluoroscopy, etc. poses a challenge for trainees to learn interventions and diagnostic techniques core to the profession internationally. Funding travel was and is a very large barrier. Additionally, as the first in their nations, current fellows have yet to meet and work with another specialist in the field of PRM.

Ghana as a case study

Ghana, a country in West Africa was for many years without a PRM training program until the year 2018 when the first such program was established. Prior to this, there was no PRM physician in Ghana. Christian et al did a study in 2016 focusing on rehabilitation in Ghana and noted that only 17% of the patients who required rehabilitation in Ghana's second biggest teaching hospital and referral center received it. And this care was in the form of only physical therapy provided once a day for less than a week (28).

In 2018, the Ghana College of Physicians and Surgeons (GCPS) through its Family Medicine faculty partnered with the IRF and approved a "Sports, Exercise and Rehabilitation Medicine" (SERM) fellowship program to train Family Physicians in the field of PRM and Sports Medicine. The 2-year training in SERM in Ghana was adequate to train physicians because unlike other countries where the training takes 4 years with trainees coming straight out of medical school, the physicians being trained in the IRF program had already undergone a 3-year training in Family Medicine, qualifying as specialists and had competencies in patient safety and quality patient care, interpersonal skills and communication, medical ethics and public health, quality assurance, professionalism and research skills among others, similar to what has been outlined in the ISPRM's PRM core competency document.

The program utilizes collaboration between the GCPS, IRF physician members and IRF's recruited experts in the discipline of PRM around the country to facilitate and build faculty training and create local training programs led by alumni. In addition to the online lectures, fellows training in the program go through clinical rotations in other medical specialties including Neurology, Neurosurgery, Trauma and Orthopedics, Radiology, Rheumatology, Cardiology and Psychology. They also spend time in the largest prosthetics and orthotics center in West Africa learning about the common injuries presented as well as the various products provided. Prior to COVID-19, educational exchange visits between Ghanaian physicians and academic centers in the

United States (University of Michigan) was a part of the fellowship training. However, in lieu of travel restrictions brought about by the COVID-19 pandemic, the fellowship focused solely on virtual educational exchanges.

The delivery of PRM training through the Sports, Exercise and Rehabilitation Medicine (SERM) sub-specialty program under the GCPS in Ghana presented the opportunity to incorporate PRM into the training of medical students. This approach in addition to exposing the students to this specialty field, also guides them towards pursuing a career in PRM.

Again, with the WHO and countries pushing for Universal Health Coverage (UHC) to reach lower income populations with subsidized healthcare, it becomes imperative that medical doctors often encouraged by medical schools to work largely at the primary care level are given some pre-service exposure to PRM in line with the framework of action for UHC in Africa. The GCPS' faculty of family medicine has an existing family medicine immersion program available within the University of Ghana Medical School (UGMS), Ghana's oldest medical school. With PRM training in the GCPS being under the faculty of family medicine, this turned into a fortuitous opportunity to introduce PRM to senior clerks at the L600 level in 2021. Within a 1-week senior clerkship program, one of the morning tutorial sessions is devoted to SERM, during which a fellow introduces the fundamental concepts of PRM laced with some problem-based scenario learning. In 2021, about 200 L600 students at UGMS received this immersion in SERM, in four divided cohorts. Just within the same year, one of the private medical schools also in Accra has incorporated a similar program into its undergraduate medical program, with their smaller number of final year students being trained in a single cohort.

The PRM training built within the SERM program however has not been without challenges. The first fellow faced the pioneering challenge of promoting PRM among colleague physicians. Establishing a practice and developing a clinic and inpatient unit to treat patients is paramount not only to the future outcomes for patients but also to improve hands on and case-based learning opportunities for the training program. To improve visibility both oral and poster presentations highlighting PRM and its role in managing various conditions (Cerebral Palsy, Stroke, Spinal Cord Injuries, Back Pain) were made at GCPS conferences and continuous professional development workshops. Presentations were also made at the clinical meetings of the various PRM associated specialties including orthopedics, paediatrics and internal medicine. Teaching sessions were organized for family physicians who were the specialists with the largest encounter with persons who would require rehabilitation. These activities have resulted in basic PRM training also being incorporated into the 3-year Family Medicine residency training involving lectures and clinical rotations in the fellow's practice thus further exposing them to the field of PRM.

Discussion

The long-term goal of the IRF is to help develop local Ghanaian and other LMICs fellowship and training programs for PRM by training and supporting rehabilitation specialists. IRF's main purpose will become that of a supporting partnership to local training programs, though there will be continued educational exchanges for the benefit of both LMICs and high-income countries.

The approach of incorporating PRM training within an already established undergraduate program for family medicine, looks to be a viable model, although it is still too early to assess the full impact, and promises to yield huge dividend in the near rather than long-term future. It also bodes well for an LMIC like Ghana which needs to bridge the rehabilitation access gap very quickly within the context of UHC.

The IRF is currently working on the development of an online platform to house recorded didactics, journal articles, videos, and discussion platforms. Next steps in curriculum development include more direct assessment of the learner's knowledge, as well as program evaluation of the content and learning process. Further content banking of modules for enhanced access for repetition and reference. Additionally, increased collaboration with the sponsoring in-country institutions to better align didactic learning sessions, focused on building blocks of core PRM knowledge, with hands on clinical experiences. For example, aligning stroke and brain injury didactics with neurology rotations.

The ultimate goal of the IRF fellowship is not to train African fellows. It is to train Africans who can train the first generation of African PRM physicians. The early success bodes well for this vision, as graduates have already become active leaders and teachers.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

AT designed the concept and drafted the manuscript with important intellectual input from MN, HS, AH, and BQ. AT, MN, HS, and AH assessed and critically appraised the manuscript. All authors have read and approved the final version of the submitted paper and agree to be accountable for all aspects of the work as presented.

All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Strengthening education in rehabilitation: Assessment technology and digitalization

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Rehabilitation is a discipline increasingly growing around the world due to several reasons, but probably the most important one is aging population and chronicity. A need to harmonize education has been identified, and although several International organizations such as the European Union of Medical Specialists (UEMS) and the International Society of Physical Medicine and Rehabilitation (ISPRM) have defined standards, given the quick growth of new evidence and assessment methods an urge to establish new ones arises. Functional assessment and tools used to do so are key in rehabilitation processes. This comprises self-reported questionnaires, conventional clinical evaluation but more notably high technology assessment methods, such as movement analysis systems, posturography, different types of dynamometers and kinesiologic electromyography among others. More recently, a wide range of wearable systems has been introduced in patient assessment. This is generating many published protocols as well as reliability and validity studies. The objective of this narrative review is to present main assessment technologies relevant to rehabilitation, its situation of this specific area in pre-graduate and post-graduate rehabilitation educational programs, and to elaborate a formative proposal including technological foundations of assessment and also highlighting the importance of solid reliability and validity of assessment methods comprehension. The main objective of this proposal is to provide basic knowledge about rehabilitation and methodologies for outcomes evaluation, including new technologies, to all health professionals, but especially to those who work or will work in the field of Rehabilitation.

KEYWORDS

rehabilitation, education, assessment, technologies, digitalization

Introduction

Rehabilitation, according to the World Health Organization (WHO), is the set of interventions designed to optimize function and reduce disability in people with health status conditions in relation to their environment. The conditions can refer to acute or chronic diseases, dysfunctions, injuries or trauma, or to other circumstances such as pregnancy, advanced age, stress, congenital anomalies or genetic predispositions (1). Anyone with a medical condition who experiences some form of

function limitation such as mobility, vision, or cognitive ability may require rehabilitation. Due to the demographic evolution of most countries, marked by the increase in life expectancy and chronicity, it has been estimated that the population likely to require some rehabilitation intervention in the world is 2,410,000,000 people, therefore, this discipline challenges all health professionals, beyond specialized physicians. Rehabilitation consists of interventions aimed at addressing deficits, activity limitations, and participation restrictions, as well as personal and environmental factors (including technical assistance) that have an impact on function. To design these interventions, it is essential to define individualized objectives for each patient.

Both for the design of the best intervention and for outcomes measurement in Rehabilitation, it is essential to carry out a correct and complete function (namely bodily functions as described by ICF) evaluation of each patient. The concept of function and its evaluation refer to the capacity of the person to carry out activities or tasks necessary for self-care and interaction with the environment, as well as the measure of that capacity. It is a broad concept, which encompasses the physical, mental, affective and social spheres of the person (2). These functional evaluation skills must be part of the rehabilitation professional's own competences. The accuracy of assessments will determine whether available resources are used with sustainability and effectiveness, establishing concrete and personalized objectives in each case and achieving the best possible result in terms of structure, function, activity and participation of the person (3).

Among the instruments for the measurement of functional capacity, the assessment scales or Patient Reported Outcome Measurements (PROMs) have had a great development in the last 60 years, being widely known and used by rehabilitation professionals. The usefulness of such tools has been widely demonstrated and they have been found to slightly improve quality of life and increase communication between patients and their doctors (4).

Despite the usefulness and multiple advantages of these tools, there is no general consensus on which to use ideally in each case, and there may be problems with the choice, interpretation and use of the information of the scales for rehabilitation processes. On the other hand, we must ensure that they are validated, reliable and adapted to the local language, ideally through a cross-cultural adaptation process (2). In addition, in most cases they are not exempt from some component of subjectivity, arising from the tested patient or the tester. Such gaps make it essential to confront results from clinical scales with objective body function data, like those obtained by means of appropriate biomechanical assessment technologies.

For years, a wide variety of tools and technologies for biomechanical and functional assessment have emerged. These techniques approach functional assessment in a quantitative and objective way, focusing on the analysis of the physical sphere of different human functions and activities. The use of different kind of technologies enable the study of physical parameters during a given activity, like gait or reaching (5) or while performing any function, like balance or muscle power function. Those parameters may be related to different aspects, highlighting the following:

- How the movement is performed: kinematic properties refer to movement quality, and include parameters like range of motion, speed or acceleration. These might be measured with varied tools of different complexity, from classic goniometers, to electrogoniometers, inertial sensors or photogrammetry in 2, 3, and even 4 dimensions. Not every technique allows registering every kind of parameters, as some may only measure range of motion or speed.
- Causes of movement and muscle power function: forces are in turn responsible for movements. In this case, measurement tools can focus on the analytical study of muscle function through isometric and isokinetic dynamometry, or on the study of other types of variables such as ground reaction forces through dynamometric platforms, widely used for the evaluation of human gait and also the basis of posturography.
- In the assessment of physiological signals, the use of electromyography, mainly surface, for the analysis of muscle activation during activities such as walking is relatively widespread. There are also other types of techniques for the analysis of physiological signals such as heart rate, blood pressure, respiratory volumes or tissue temperature, among many others.

Though some of these techniques have been classically located within a movement analysis lab, in recent years a wide range of simple wearable systems and smartphone-based tools have arisen, allowing an objective register of daily overall or specific activity of patients not only within clinical settings, but also in the community.

The clinical utility of biomechanical analysis technologies has been proven in different areas. One of the most evaluated activities has been gait, for which biomechanical analysis has been related to greater confidence in decision-making, change in decisions and an improve of the agreement between clinicians (6). A high degree of evidence has been proven either in the relationship between biomechanical analysis and better functional outcomes in populations such as children with cerebral palsy or adults with acquired brain injury, both in relation to surgical treatment and non-surgical management. In relation to the above, the performance of this type of analysis can lead to a saving of resources in children with cerebral palsy (7).

Another of the most analyzed activities is balance, through the well-known posturography (static or dynamic). This analysis technique has been used for years, both for functional

assessment and for the treatment of balance disorders, and among other achievements it has allowed the detailed description of the pathophysiology of different pathologies that affect balance (8). Its clinical usefulness has also been proven for the evaluation and identification of specific populations, such as those with dizziness of cervicogenic origin (9).

As for dynamometry, isometric grip (namely Jamar) dynamometers (10), isokinetic dynamometry, the "gold standard" of dynamometry assessment (11–13), and hand-held dynamometry (14, 15), show a growing evidence of reliability and validity in several clinical situations. For instance, at this moment grip strength Jamar dynamometer test is the first criteria to detect sarcopenia (16).

To be truly adequate for its use in clinical practice, any of the above-mentioned tools should be reliable, valid and with high responsiveness. Reliability is the property that indicates that the measurement offers equivalent results when carried out under similar conditions. This property is evaluated through inter-tester reliability studies or in test-retest studies. Reliability is an essential prerequisite to render a test valid. On the other hand, validity is understood as the property that indicates that the measure really represents the aspect to be evaluated, that is, the correspondence between what is measured and the reality that is to be represented. Normally, the validity of a measuring instrument is evaluated by comparing with a benchmark or gold standard. Finally, responsiveness or sensitivity is the tool capacity of detecting changes. Clinicians must know well these concepts and know how to identify them in each measurement tool, in order to always choose the most appropriate.

In addition to selecting the appropriate measurement tool, healthcare professionals must handle all existing generated data with expertise, including that obtained through a detailed functional assessment. Only by taking all the information of the person into account from a holistic view, will a true personalized medicine be possible. Given the high amount of data and information sources available, the management of these can become extremely complex, with the associated risk of ignoring some relevant aspect in decision making. In this context, both the rise of techniques such as Big Data and Thick Data, which allow the efficient management of large volumes of qualitative and quantitative data, and the advancement of different modalities of Artificial Intelligence for the analysis and interpretation of such data, can facilitate and get the most out of all the available information. In turn, this leads to the design of algorithms aimed at improving diagnoses, assisting in decision making, or offering prognostic information, among other functionalities (17–19). These approaches have shown their effectiveness in several areas such as oncology (20), musculoskeletal injury physical therapy (21) or stroke management (22).

Considering the higher and higher importance that Artificial intelligence is reaching among clinical fields, more training for health care professionals and decision makers about its strengths, limitations and applicability is needed. This knowledge would additionally boost the adoption of these technologies by health systems, with the advantages it might bring (19). There are examples in certain areas where Artificial Intelligence has become a common reality, as is the case of medical imaging. Thus, some authors have even proposed training programs on artificial intelligence aimed at radiology medical residents (23). But training in this area, adjusted to the needs of each group, must be extended to other medical specialties and other healthcare workers.

In short, the progress of Rehabilitation as a specialty involves optimizing the ability to evaluate function, accuracy in the measurement of results and actualized skills in data management pertaining the patients. Only this way will a true valued-based and person-centered medicine be possible, considering the existing scientific evidence and supported by all the knowledge generated thanks to the advance of data recording and analysis technologies.

Training deficits in rehabilitation

Surprisingly, despite the increasing need for rehabilitation recognized by the WHO in relation to the large increase of persons with functional deficits, the training of future physicians and other health professions suffers from significant deficits in terms of specific competences related to the discipline.

The highly increasing number of persons with disability around the world requires an active involvement of all health care professionals, beyond those dedicated exclusively to rehabilitation. That is why all doctors and healthcare professionals would require a basic knowledge about this discipline. As an example of this, among the modules considered mandatory in the curriculum of the Degree in Medicine described in Spain (24), the one related to the "Diagnostic and Therapeutic Procedures", which comprises 40 European credits, must include, among other competences, that of [… *Know the fundamentals of rehabilitation, the promotion of personal autonomy, the functional adaptation of the environment, and other physical procedures in morbidity, for the improvement of the quality of life* …].

In spite of this, specific training programs of the Degree in Medicine of different Spanish faculties show a scarce representation of Rehabilitation. For example, in some cases it is taught as a compulsory subject but the teaching load is only 3 credits, in others it is only included as an optional subject, and on some occasions, it is not even included among this last group of subjects. This implies that many future medical professionals will graduate without basic knowledge

about this subject. In line with this, a survey aimed at identifying training needs carried out by the Biomechanics Institute of Valencia, in collaboration with the Spanish (SERMEF) and Valencian (SVMEFR) Societies of Physical Medicine and Rehabilitation in 2010, showed that 28% of the 138 medical specialists rated the training received during the period of degree or bachelor's degree either insufficient or totally absent.

Needless to say, if the teaching load referred to Rehabilitation as a discipline is low, that related to the biomechanics of the musculoskeletal system and functional assessment, whose teaching is intertwined in the previous one, is even lower, being too often practically nonexistent.

In the surveys carried out within the framework of the Erasmus Plus "TEACH" project to 104 undergraduate teachers in health sciences from twelve different countries in Europe, only 32% declared that they had received some type of official training on the biomechanics of the musculoskeletal system during their university stage, a figure that drops to 17% when asked about instrumented analysis techniques. Even more striking is the fact that 46% said they were unfamiliar with the concept of functional assessment. In addition, despite the fact that 89% considered it important to include aspects related to biomechanics and instrumented analysis in the degrees of health sciences, 69% said that they are currently not taught or do so in a very insufficient way (25).

Other fundamental health profiles for any health system, such as nursing, also count on scarce training in these concepts. As an example, in the training program of the Degree in Nursing of Spain (26), although including the acquisition of skills to understand and evaluate the functioning of the person in their environment, or understand the interactive behavior of the person, no specific mention is made of the concept of function and functional assessment in all populations and pathologies, and there are no contents related to Rehabilitation or its branches. This is concerning, since nurses are a cornerstone in many programs of care, prevention, detection and treatment of any pathological and/or vital process. These professionals are involved in decision-making and have a more holistic view of people that can help detect situations where it is necessary to implement a rehabilitation intervention. Therefore, it is imperative that they know the most relevant aspects of Rehabilitation, including those related to the measurement of function.

The specialists in Physical Medicine and Rehabilitation themselves also suffer from a lack of regulated and sufficient training in functional assessment and biomechanics area. In the training program of the specialty included by the Spanish Ministry of Health (27) it is indicated that, among other aspects, the doctor specialized in training must *[… acquire adequate knowledge on biomechanics and pathomechanics of the Musculoskeletal System, as well as acquire skills in the various functional assessment systems: assessment scales, such as International Classification of Functioning (ICF), American Medical Association (AMA) guidelines, Functional Independence Measurement (FIM), and instrumental methods: dynamometry, isokinetics, posturography, gait analysis, etc.*]. In the same way, the training program proposed by the Panel of Physical Medicine and Rehabilitation of the European Union of Medical Specialties (UEMS), includes training in biomechanics and functional assessment, both clinical and instrumented, as well as the acquisition of skills for the management of the different evaluation methodologies (28). However, in real practice this aspect is sometimes relegated to other competences considered as more critical, remains in the hands of the preferences of the doctor in training themselves or of their mentors, or it depends on an unequal availability and access to both training resources and to the analysis methodologies.

In a survey published in 2021 (29), 77.7% of the 112 physical and rehabilitation resident doctors surveyed pointed to Biomechanics as an area of interest, and yet only 18.8% declared having sufficient training resources available. Likewise, the results of a questionnaire administered in the context of the Leonardo Da Vinci "Biomechanics4rehab" program (30) indicated that, of 184 Rehabilitation specialists from across Europe (contacted by the European Society of Physical Medicine and Rehabilitation: ESPRM), 87% had not completed any training in Biomechanics and/or analysis methodologies in the last 10 years, and that 56% would not know how to interpret the results of a biomechanical analysis.

The interest of healthcare professionals in improving their knowledge and skills in assessment, and specifically in Biomechanics, is also reflected in the demand for resources out of their formal training. An example of this is the Master of Clinical Biomechanical Assessment of the Polytechnic University of Valencia, whose number of students of different health-related profiles and from various Spanish speaking countries, rises to 207 in its 7 editions.

In brief, it appears widely proven that the training in rehabilitation, and specifically in functional assessment and biomechanics, is quite poor in health professionals and, more strikingly, in some cases of rehab professionals. Thus, a reinforcement of the body of knowledge in this important area is mandatory to strengthen the discipline all around the world.

Discussion and proposal

Function is part of health, and as such, it must be considered in the healing or improvement of any process, whatever its origin. However, many medical specialists focus on treating only etiology, losing sight of the treatment of function, and therefore failing to maximize the quality of life of the person.

At this moment it is clear that powerful and well-organized Rehabilitation Clinical Pathways are central in ensuring the monitoring and treatment of the functional status of persons suffering any kind of disability. On the other hand, its efficiency and sustainability will depend on the correct assessment of function and disability. High quality information is crucial to make decisions in rehabilitation, and this will improve the results of the process, reduce the degree of disability, increase the quality of life of the population, and manage resources efficiently and coherently. In the end, this will result in greater patient and professional satisfaction.

However, training gaps can be identified at the Undergraduate and Postgraduate level that concern Rehabilitation as a discipline, the mastery of tools and methodologies to evaluate functionally, and the acquisition of knowledge on biomechanics and systems of both analysis and management of information. Therefore, it is necessary a paradigm shift, that begins by promoting training in Rehabilitation from Health Schools, giving space to the learning of biomechanics and methodologies for outcomes measurement to all future physician, regardless of their future specialty, and to other allied health professionals. As for specialists in Physical Medicine and Rehabilitation, it is necessary to standardize the skills and training resources available in relation to biomechanics, functional assessment methodologies, use of new technologies and systems for data analysis and management (31).

To address this, the Panel on Physical Medicine and Rehabilitation of the European Union of Medical Specialists (UEMS) advocates for increasing the subjects related to the specialty in undergraduate training, and proposes the delivery of essential content related to Rehabilitation. As for the competences of the specialist doctor, this association has also developed guidelines that lay the foundations for a harmonized, complete and structured training program, in order to unify criteria and standards in Europe. Among the proposed contents, those related to functional anatomy, biomechanics, and functional assessment within the framework of the International Classification of Functioning (CIF) through the use of clinical methods and instrumental techniques stand out (28). However, not enough importance is yet given to training in new technologies for data management and analysis.

To conclude, and in line with all the above, we consider that **all healthcare professionals (doctors, nurses, etc.)** should have quality didactic resources in at least the following areas of knowledge, always from a practical approach and regarding clinical application:

- Disability and functional assessment within the framework of the ICF. Concepts and methodology.
- Fundamentals of biomechanics: movement and forces. Instrumental techniques for their analysis.
- Basic concepts about biomechanics of gait, balance, spine and most important activities of daily living.
- Main functional assessment tools. Requirements: concepts of validity and feasibility.
- Research methodology. Fundamental concepts on document management, sources of information and statistics in the field of health. Clinical applications of data management systems and artificial intelligence: basic concepts, examples and role in helping diagnosis, decision making or prognosis.

For those professionals working specifically in the rehabilitation field, in addition to the basic knowledge in the areas described, a more in-depth training is proposed, addressing the following aspects:

- Disability and functional assessment according to the ICF. Study of body functions and structures, activity and participation of the person. Concepts and evaluation methodologies.
- Basic physics related to the study of movements, forces, pressures, physiological signals and morphometric parameters. Understanding each parameter.
- Instrumental techniques for its analysis.
    - Force and pressure analysis: isokinetic and isometric dynamometers, dynamometric platforms, pressure platforms and blankets, instrumented insoles.
    - Movement analysis: electrogoniometers, inertial sensors, 2D/3D and 4D photogrammetry, image recognizing systems based on IA.
    - Physiological signals: electromyography, thermography and others.
    - Morpho and anthropometric analysis: 3D and 4D scans, systems based on IA.
    - New technologies for functional assessment in clinical settings and in the community: wearables and smartphone systems.
- Biomechanics of gait and balance. Normal functioning and main biomechanical alterations in different pathological contexts and considering the activities of daily living. Techniques of analysis and interpretation of results.
- Biomechanics of the spine, upper extremity and lower extremity. Normal functioning and main biomechanical alterations in different pathological contexts and considering the activities of daily living. Techniques of analysis and interpretation of results.
- Concepts on objective functional capacity evaluation. Validity, feasibility, accuracy and responsiveness.
- Concepts of Big Data and Thick Data. Concepts and types of Artificial Intelligence. Application in the clinical field regarding prognosis, prevention, diagnosis and decision-

making in Rehabilitation. Ethics and Data Management considerations.

- Specific areas of Rehabilitation and usefulness of biomechanical analysis in the clinical context. Analysis of movements, forces, pressures, physiological signals and/or morfometric parameters, regarding evaluation methodology, interpretation of results and clinical applications in:
  - Neurorehabilitation.
  - Disorders of the musculoskeletal system.
  - Amputees.
  - Spinal deformities.
  - Others: miscellaneous.

In addition, it would be advisable to establish a network of health centers with infrastructure and resources to accommodate internships in biomechanics and instrumented analysis, and this network should be known and accessible to all future rehabilitation professionals.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

Author contributions

All the signatory authors have participated in the writing of the present article, making significant contributions and meeting the relevant authorship requirements in relation to the degree of involvement in the project and in the writing of the article. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Implementing functional electrical stimulation clinical practice guidelines to support mobility: A stakeholder consultation

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Functional Electrical Stimulation (FES) has been used to support mobility for people with upper motor neuron conditions such as stroke and multiple sclerosis for over 25 years. Recent development and publication of clinical practice guidelines (CPGs) provide evidence to guide clinical decision making for application of FES to improve mobility. Understanding key barriers to the implementation of these CPGs is a critical initial step necessary to create tailored knowledge translation strategies. A public involvement and engagement consultation was conducted with international stakeholders including researchers, clinicians and engineers working with FES to inform implementation strategies for CPG use internationally. Reflexive thematic analysis of the consultation transcripts revealed themes including inconsistent use of CPGs, barriers to implementation such as limited access to FES and low clinician confidence, and the need for a tiered education approach with ongoing support. Insights derived from this consultation will inform the development of knowledge translation strategies to support the next steps to implementing FES use for mobility.

KEYWORDS
clinical practice guidelines, functional electrical stimulation, upper motor neuron conditions, neurorehabilitation, rehabilitation

Introduction

Functional electrical stimulation (FES) to improve mobility involves electrical stimulation of peripheral nerves in the lower extremity for improving locomotion or strengthening muscles (1). Clinical guidelines that recommend FES to improve foot drop in people with upper motor neuron conditions have been in existence since 2009, since the introduction of National Institute for Health and Care Excellence (NICE) guidance (2). Clinical practice guidelines (CPGs) are defined by the Institute of Medicine (IOM) as "a set of recommendations, involving both the evidence and value judgments regarding benefits and harms of alternative care options, addressing how patients with that condition should be managed, everything else being equal" (3). CPGs supporting healthcare professionals to improve lower limb function and mobility in individuals with stroke and upper motor neuron dysfunction are relatively new (4) or in development (5). These CPGs provide a synthesis of current scientific evidence, expert clinical experience, and patient preferences. CPGs have the potential to support clinical decision making, reduce practice variability, assist in educating patients and caregivers on best practices, aid policy makers in the allocation of healthcare resources, and inform the development of educational courses (3). However, the benefits to patients through implementation of evidence into practice is often not realised, with only about 14% of published evidence making an

impact on clinical practice after an average of 17 years (6). Insufficient clinical impact achieved indicates that a more active approach is required through barrier assessment and tailored knowledge translation implementation strategies (3, 4).

Knowledge translation is defined by the National Center for the Dissemination of Disability Research (NCDDR) as "The collaborative and systematic review, assessment, identification, aggregation, and practical application of high-quality disability and rehabilitation research by key stakeholders (i.e., consumers, researchers, practitioners, and policymakers) for the purpose of improving the lives of individuals with disabilities" (5). Increasing clinical implementation through knowledge translation must be a dynamic and iterative process to effectively impact the health and wellness of individuals and to strengthen the healthcare system (7). The Knowledge to Action Framework developed by Graham et al. suggests that once knowledge is created, it must be put into action through a series of dynamic phases that include assessing barriers and facilitators to knowledge use, developing implementation interventions, and adapting strategies to specific local needs (7). The CPG development process relating to FES use for improved mobility has synthesized evidence of different types to create new knowledge. The subsequent goal of implementing FES CPGs is to support effective and efficient clinical decision making, enabling the best possible care and thereby improved patient outcomes.

The next step in this knowledge to action plan includes the assessment of barriers to knowledge use to ensure that the CPGs achieve positive change. To achieve this goal, it imperative to gain the thoughts and perspectives of clinicians and other stakeholders using or considering the use of FES (8). Public engagement and involvement consultations play an important role in the dissemination of research and can improve the quality, relevance, and ultimately the usefulness of the knowledge to action products (9). Publications on this topic by Howlett et al., 2018, Auchstaetter et al. 2016, and Tedesco Triccas et al. 2021 identified barriers to FES use including gaps of education or training for FES use and lack of resources (10–12). Each of these surveys were completed prior to the publication of the recent evidenced based CPG in 2021, and were online surveys only distributed to one specific region, potentially limiting the global application of the results. Prior publications also did not include interactive discussion which is a critical element to understand the people's views and lived experiences (13).

While barriers have been previously documented, the ultimate focus of this consultation was to understand how to move beyond all these barriers. Thus, the purpose of this public engagement and involvement consultation was to engage in discussion with individuals from a variety of countries that are using FES to consider current practice patterns, use of CPGs, perceived barriers to CPG and FES use, and to gain an understanding of priorities for education and training. This international perspective will be used to inform the design of international CPG implementation strategies including education outreach that will support FES use to improve mobility.

Methods

A public engagement and involvement consultation was conducted to obtain the viewpoints of key stakeholders involved in the provision of FES clinical services to patients (14). Three virtual workshops were held between September 2021 and May 2022, with a combined total of 172 participants. Information was compiled to address the purpose of the consultation, which was to gather information from individuals using FES from a variety of countries to document current practice patterns, perceived barriers to FES use, and use of CPGs. This international perspective was sought to assess the barriers to knowledge use to identify, design and implement educational needs across different geographical areas and health systems.

Consultation development

A discussion plan for the consultation was developed by the authors of the recent Clinical Practice Guideline (TJ, LB) (4) and by a CPG in development (TS, CB, AA, SJ, JB) (15). The expert author panel included academics, researchers and clinicians with experience using FES. The intention of the discussion plan was to use a pragmatic approach to develop a brief series of guided open-ended questions and follow-up questions, (**Table 1**). The aim of the consultation was to use a responsive interviewing structure to provide participants an opportunity to describe their experiences using FES in the real world, and to engage in the discussion about the role of CPGs and the potential next steps of implementation (13). The discussion plan covered topics related to participant role and interest in FES, geographical location, practice patterns with FES, knowledge of and barriers to use of CPGs and perceived educational or training priorities for translation of evidence into clinical practice.

Workshop and consultation administration

All consultations were held virtually using the videoconferencing platform Zoom (Zoom Video Communications, 2016) (14). The first session was held as part of a workshop entitled "Development of

TABLE 1 Discussion plan.

What are your roles/interests relating to Functional Electrical Stimulation (FES)?
What type of FES are you familiar with?
Is FES used clinically in your region/country?
If you do not use FES, can you share your reasons with us?
Does your region/country use any FES clinical guidelines currently? Which? How?
If you do not use clinical guidelines, can you share your reasons with us?
Is there anything that you think will make it more likely that clinical guidelines will be used in your region/country?
Do you think there would be/are any barriers to using/implementing clinical guidelines relating to FES for mobility? What may they be?
In what way do you use FES in your clinical practice?
If you use FES, how do you decide which patients are able to benefit?
Do you feel that that there is a need to use guidelines differently in different countries?
If so, what would these needs be?
What are the priorities in this area for development, education, and training?

Clinical Guidelines for FES in Mobility" during the international virtual Rehab Week 2021 conference. This well-established biennial conference is sponsored in collaboration with the International Functional Electrical Stimulation Society (IFESS) among other societies and typically attracts a variety of participants including researchers, clinicians, engineers, and industry specializing in FES. The workshop was advertised through RehabWeek conference promotions and through social media channels. The workshop was open to all conference attendees, and anyone who was present for the initial introductory portion of the workshop was invited to participate in the consultations portion. Participants were provided with the option to participate in the workshop without participating in the consultation. The second consultation occurred during a virtual international workshop titled "Bridging the Gap between Functional Electrical Stimulation Research and Clinical Implementation" sponsored by the International Functional Electrical Stimulation Society (IFESS) and the Association of Chartered Physiotherapists In Neurology (ACPIN). This freely available workshop was made available through IFESS and ACPIN email distribution lists and social media channels. This virtual workshop included an initial introduction followed by an invitation to participate in a voluntary small group consultation. The third consultation included invited clinicians from the United States. Stakeholders working in the area of FES were invited through email requests from the panel. This consultation started with an introduction to the project after which attendees were invited to participate in the small-group consultations. All consultations were voluntary, and participants were not compensated for their time. Consultations were offered on different days and times to accommodate the varied time zones of the expert panel and the participants. All consultations were offered virtually due to ongoing Covid 19 pandemic restrictions, and to encourage and accommodate a broader audience.

The beginning of each workshop aimed to provide background information about the development and implementation of CPGs for FES. Participants were given the opportunity to ask questions prior to participation in the optional consultation session. Participants were informed of the intended use of their views during the consultation, and that their views would be recorded. and provided with the opportunity to opt-out. Joining the optional zoom breakout room indicated agreement to participate in the consultation. Follow-up consultation was then held in zoom break-out rooms to gain insights into current practice patterns and key challenges with FES and CPG implementation.

Consultation outcomes

Audio-recordings of the consultations were recorded in zoom and transcribed verbatim. Transcripts were compared to the audio recordings by expert panel members for accuracy and all participant information was deidentified to maintain anonymity. The transcripts were reviewed using an iterative process, and themes were identified and coded using NVivo Qualitative Analysis software; QSR International, Burlington, MA. Using a framework analysis two members of the expert panel (LB, TS) read the transcripts from the open-ended questions to familiarize themselves with the responses (13, 16). Using reflexive thematic analysis with an iterative process, the transcripts were read again by each reviewer and initial codes were identified (13, 17). The 2 reviewers (LB, TS) then discussed and compared initial codes and categorized similar conceptual codes into emerging themes related to each question. Themes were agreed upon and organized by each objective of the consultation including participant demographics and practice patterns with FES, awareness of CPGs, and perceived barriers to FES use (17).

Results

Background information and practice patterns

The virtual consultation was provided on 3 different occasions. Of the 172 participants across all 3 workshops, a total of 18 chose to fully participate in the consultation. Geographical representation was oriented around Europe and North America and included representation from Canada, Denmark, Ireland, Italy, the Netherlands, the United Kingdom, and the United States. Participants were predominantly physiotherapists with representation from clinicians, educators, researchers, and engineers (**Table 2**). Participants were asked which diagnoses they considered using FES as an intervention. The most common diagnoses included stroke, spinal cord injury, multiple sclerosis, brain injury, transverse myelitis, and cerebral palsy.

Participants' experience levels with FES ranged from the novice to expert level. Interventions with FES included to improve patient mobility (dropped foot) or using FES as a therapeutic modality within intervention sessions for functional training or focal muscle strengthening. Some participants reported using devices such as FES cycling to enhance exercise participation. Frequencies of use of FES in clinical practice varied from sporadic to daily. Most clinic settings were described as providing a broad range of interventions, while some described the clinical setting in which they work as a FES specialty centre or service to which individuals are referred for the primary purpose of assessment for and interventions using FES. Participants with the highest confidence relating to FES and most

TABLE 2 Demographic information.

Occupation	% of participants
Physiotherapist	72
Orthotist	<1
Engineer	11
Researcher	11
Geographic location	
United Kingdom	44
United States	22
Canada	11
Netherlands	<1
Italy	<1
Ireland	<1
Unknown	<1

consistent use noted having access to a training structure and support network.

Current use of CPGs

Participants were asked to discuss their current use of clinical guidelines in practice and any barriers that may impact FES use or the implementation of a CPG. Participants were aware of the NICE guidelines published in 2009 but were inconsistently aware of clinical guidelines available for use of FES post stroke recently published in 2021 (2, 4). When discussing barriers to implementation of FES CPGs themes included limitations in the scope of CPGs and inconsistent awareness and use in practice. When discussing CPG scope, one participant with an academic background noted: "*I do not believe we are asking the right clinical questions before we go into those guidelines. What specifically we are missing is: what does the patient want to gain out of using the technology?*" Participants commented that current guidelines needed to be more specific to health conditions or interventions and did not appear to clearly define a clinical decision-making process. For example, a practitioner said: "*to actually use them for the clinical practice, or within, they are not descriptive, or descriptive enough to, they don't tell you how to do it, just that there is evidence out there, it has a benefit.*" Participants also felt that a CPG may not provide enough detail or may be difficult to carry over into facility guidelines: "*we've had discussions about the FES and AFO clinical practice guidelines …. but we don't have hospital or a department guideline for clinical, so we don't have those for anything.*" Potential benefits to CPGs were also noted by participants and included a potential to positively impact reimbursement and access. "*I think in the UK the guidelines help with funding … and with a guideline at least there is a legitimate background for ordering it.*" (**Figure 1**)

Perceived barriers to FES use

Themes related to barriers to FES use included clinician skill level and confidence, limitations in funding, and inconsistent educational offerings. Clinician skill level and confidence with FES technology were mentioned by several participants. One clinician stated: "*I trained up on quite a few different devices but have not had access to those devices, and I think my biggest one is noticing how that lack of confidence just writes you off so quickly*". Other themes included economic barriers such as limited insurance coverage and constraints accessing FES within a given geographical location. Clinicians in the United Kingdom described unequal provision of healthcare resources depending on the person's geographic area: "*It's a post code lottery; it depends on what area of the country you live in*". Many participants across geographic regions noted various challenges related to timely access: "*I think a lot of people are aware of it and know the benefits but accessing it is something, it's launching such an administrative journey to try and get that it doesn't result in success.*" … "*I did qualify in using FES but it was very difficult to access in my clinical practice, so I reverted to orthotic practice as standard.*" (**Figure 2**).

Participants described varied and inconsistent educational offerings from entry level to advanced practice. Some participants noted FES was presented in pre-registration neurological modules, while others commented that it may not be introduced at the entry level at all: "*It's mixed, it depends on the university…. I do think there is definite differences in the education, who learns about these and who does not.*" Some participants attended courses on FES application as practicing clinicians. However, a lack of support following this instruction was noted as a barrier to consistent implementation: "*personally, my experience was I went on the course, I got to understand it, I did quite a bit on the course, but then I came locally, and I saw a few patients, and when I was only seeing one, two a month, you don't build up the expertise and in the end I thought that I'm not getting enough practice to maintain my skills*".

Identification of educational needs to inform implementation strategies

During the consultations participants were asked to discuss strategies that would impact their likelihood of including FES and CPGs in clinical practice, the priorities for development, education, and training, and if there is a need to use guidelines differently in different countries. Overall themes for educational needs consisted of improved foundational knowledge, ongoing clinical and peer support, and access to an expert or consistent resource. Participants

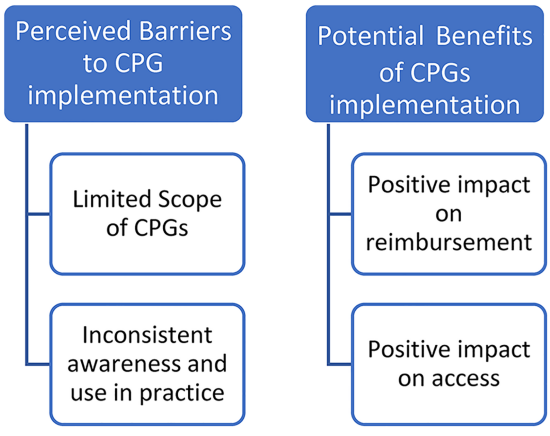

FIGURE 1
CPG use and implementation. CPG, clinical practice guideline.

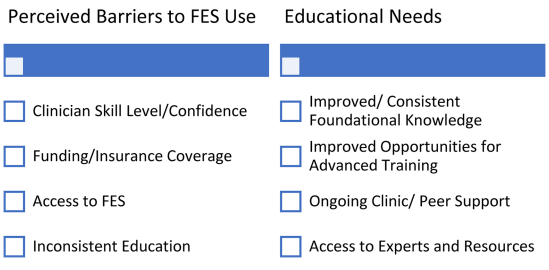

FIGURE 2
Barriers to FES use and educational needs. FES, functional electrical stimulation.

identified a need for improved foundational knowledge of CPGs and FES applications at the entry level of education, and the need for accredited basic and advanced training courses beyond entry level education. One participant stated: "*it really isn't something you can teach them in a day clinic, a day's course or a two-day course and then let them walk away without giving them support*."

Ongoing clinical/peer support, "hands-on" problem solving, and regular updates were suggested by most participants as strategies to improve implementation. Participants that worked in settings with successful and sustained FES use described a tiered approach to clinician training that included education aligned with mentored practice opportunities. One person explained: "*I set up a staged programme, they learn about technology, they learn about its functions, they learn how to manipulate it etc., they learn about the theory behind it, they then get to practice it on themselves, then they shadow in clinics to watch it being put on other people. Then by the fourth – fifth week they are starting to actually apply it themselves, on patients while they have got someone else in the room that's shadowing them. Then by the sixth, seventh, eight week they are left to practice on their own with a support mechanism around them where they can ask any questions*." Finally, appointing a trained and dedicated expert as a resource in a clinic was viewed as an effective strategy to enhance FES use and clinician confidence: "*I think role modelling from other colleagues helps*." (**Figure 2**).

When discussing whether CPGs need to be individualized in different countries, participants did not believe that each country or region required a unique set of guidelines. One participant commented that "*any of the CPGs that are already developed can be given to any other country or part of the world*". Some participants noted modifications such as accurate translation to different languages and considerations for cultural adaptations should be considered.

Discussion

The aim of these consultations was to gather preliminary information from individuals using FES to understand current FES practice patterns, including use of CPGs and the perceived barriers to FES use and to gain an understanding of priorities for education and training. According to Grimshaw et al. (2012), "*planned knowledge translation for healthcare professionals and consumers is more likely to be successful if the choice of knowledge translation strategy is informed by an assessment of the likely barriers and facilitators*" (8). Therefore, the insights gained from these conversations will be used to inform international CPG knowledge translation strategies including the educational needs for FES use to improve mobility.

The consultations included participants who ranged from the novice to expert level, and the applications discussed included functional retraining, muscle strengthening and exercise enhancement across varied neurologic diagnoses. The diversity in the backgrounds of participants of these small groups provides a wide range of insights into the current practice and barriers related to FES use, which may better inform potential educational needs.

Multiple barriers to effective implementation of FES were documented including inconsistent access to FES devices, decreased awareness of the evidence supporting FES use, and variability of FES education and supports contributing to a lack of confidence and overall use of FES. These barriers are similar to those identified in current research on barriers in FES use, which highlights the need for improved educational and implementation strategies with considerations for behaviour change (6, 10, 11, 18). The behaviour change research documents a lack of access or awareness of current research and a lack of clinician efficacy interpreting the research as barriers to evidence-based practice (19). The similarities in barriers identified across geographic areas suggests the potential for a global approach to implementation of CPGs for FES could be effective. Importantly, this strategy would still need to include local stakeholder involvement for individual regions in the intervention process (20).

It is important to understand the perceived knowledge gaps, including where and how they occur, when considering education strategies as a component of the knowledge to action plan. The inconsistent introduction of CPGs and FES during entry level physiotherapy education was noted as a barrier in the group discussions, indicating that there is a need for the development of standardized and consistent introduction to CPGs and FES at the entry level. The need for advanced training courses beyond the entry level was also vocalized, indicating implementation strategies designed for postgraduate accredited or competency based continuing professional development courses are needed that cater to varying levels of clinician expertise.

For successful translation of CPGs on FES into clinical practice, development of multimodal knowledge translation strategies is required to improve practice and change clinician behaviour (18–20). A systematic review by Berube et al. (2018) provides guidance that may assist in the implementation of CPGs related to FES (10). Successful increases in physiotherapists' knowledge and awareness of musculoskeletal guidelines were achieved using a variety of techniques, such as professional educational materials, presentations, and marketing materials. More positive patient outcomes were seen with face-to-face continuing education courses that included practical application as compared to passive learning from reading documents (21). Implementation interventions that were multifaceted and extended beyond a brief time period were found to be more successful, with one study suggesting that up to 8 days of training, followed by monitoring, are needed for behavioural change (22). This systematic review concluded that implementation interventions must be of sufficient length, use practical application tools, and allow time for questions and feedback (21).

Efforts to improve clinical decision making may be further supported by the recent development of a decision-making tool. The FES Clinical Decision-Making Tool was developed and tested its content validity with Canadian physical and occupational therapists (23). The tool seeks to facilitate clinical decision making with regards to appropriate parameters to use during FES treatment which is an area not currently well represented in available clinical guidelines. The FES clinical decision-making tool has not been validated in clinical practice yet but can be considered as a component of a knowledge to action plan.

Participants who were at the expert level of practice with FES attributed success in practice to a strong support network. This finding is consistent with the knowledge translation literature that suggests establishing a local champion or knowledge broker who is responsible for supporting ongoing discussions, interactive educations,

and clinical consultations as a critical step in the knowledge to action process (7, 19). Other strategies should focus on organizational, community, system, cultural, and policy levels, aiming to enhance motivation, resources, and organizational dynamics (24, 25).

In conclusion, the preliminary consultation assisted in the understanding of global barriers to CPG and FES use to inform next steps in the knowledge-to-action process to support implementation methods. It is important that evaluation frameworks are used to seek feedback on the implementation strategies and behaviour change techniques to enable evaluation of the success of CPG implementation (25, 26). The information collected can be used to improve the effectiveness knowledge translation strategies and to provide guidance about further research needed to improve CPGs. New research should then be reviewed and integrated into the CPG on a regular basis. A dynamic implementation approach will promote relevance and usefulness of CPGs, closing the gap between research and clinical practice.

Limitations

While individuals with varied backgrounds were invited to participate and the consultations sessions were held at different times to accommodate various time zones, many of the participants were physiotherapists with representation from Europe, Canada, and the United States, which limits the perspectives that provided input in this consultation. The number of participants in this initial consultation is small limiting generalizability.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

TS and LB share primary authorship. Both primary authors were involved in the design of the consultations workshops; assisting in conducting them; transcribed and reviewed for clarity all transcripts from each interviewer, organized and analyzed the data; revision and discussion of the results; revision of the manuscript; approval of the final version of the manuscript. TJ, AA, CB, and SF are secondary author who was involved in the design of the consultations workshops; assisting in conducting them; transcribed individual interviews, revision and discussion of the results; revision of the manuscript; approval of the final version of the manuscript. JB was involved in the design of the consultations workshops and assisting in conducting them. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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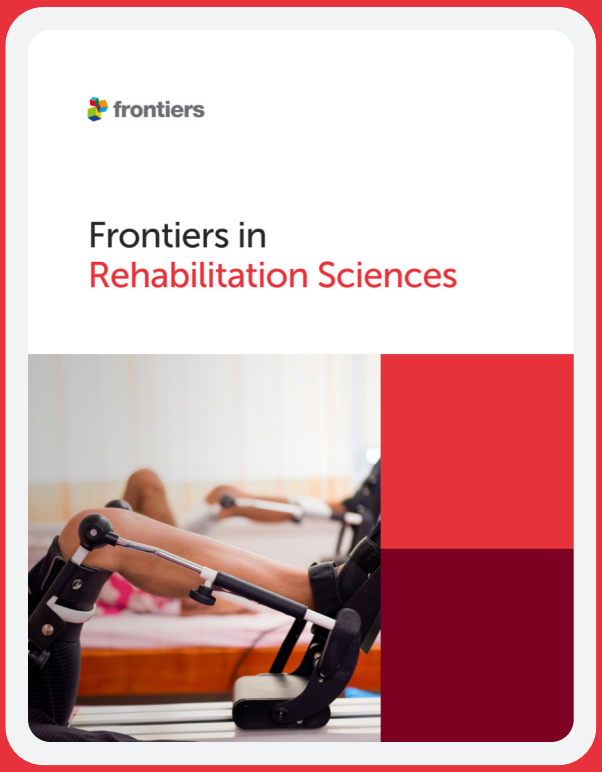

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