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Commentary

The 'wicked problem' of telerehabilitation: Considerations for planning the way forward

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Abstract: Telerehabilitation offers great promise to improved access to rehabilitation care. The rising use of technology, the increased expansion of data networks worldwide, and the growing confidence and interest of the general population to incorporate technology into their day-to-day lives via the Internet, smartphones and wearables provide fertile ground for many rehabilitation interventions. Despite this opportunity, telerehabilitation is not integrated into existing health care systems today. Most research is focused on the efficacy of the intervention without addressing the complexity of introducing a system of care that is starkly different from the current health care system in most countries. As such, implementation of telerehabilitation may be considered a 'wicked problem' in that it is extremely complex and challenging situation that is intricately linked with the social, economic and political contexts. This paper discusses telerehabilitation implementation while considering the intervention, patient, and health care system contexts in which it occurs.

Keywords: telehealth; telerehabilitation; rehabilitation; health service delivery

1. Introduction

Telerehabilitation—the use of teletechnology to enable patient and rehabilitation professional to connect for the purpose of rehabilitation education, advice, interventions and monitoring [1]—holds great potential for increasing access to rehabilitation services. This technology includes videoconferencing platforms (e.g., Facetime™, Skype™), wearable devices (Fitbit™, Apple Watch™), audio and video communication (telephone, podcasts, YouTube™), and social media (Facebook™), as well as many research-driven prototypes housed on a variety of platforms. The

introduction of affordable, accessible technology into the hands of consumers enables communication, monitoring, and feedback in ways which were not possible even ten years ago.

The rise in technology availability for rehabilitation care is paralleled by the rise in telerehabilitation research. A simple Medline™ search conducted on May 22, 2018 using the keyword 'telerehabilitation' resulted in 701 articles (of which 124 reported on at least one component of a clinical trial) with a substantial gain in published articles for the last several years (Figure 1). These numbers would likely be larger if other terms involving rehabilitation and telehealth were included. There are now several journals exclusively dedicated to the research of telehealth. Specific to telerehabilitation, research has been published in a variety of practice areas, including with people with chronic obstructive pulmonary disease (COPD) and congestive heart failure (CHF) [2], cardiac disease [3], stroke [4] and arthritis [5].

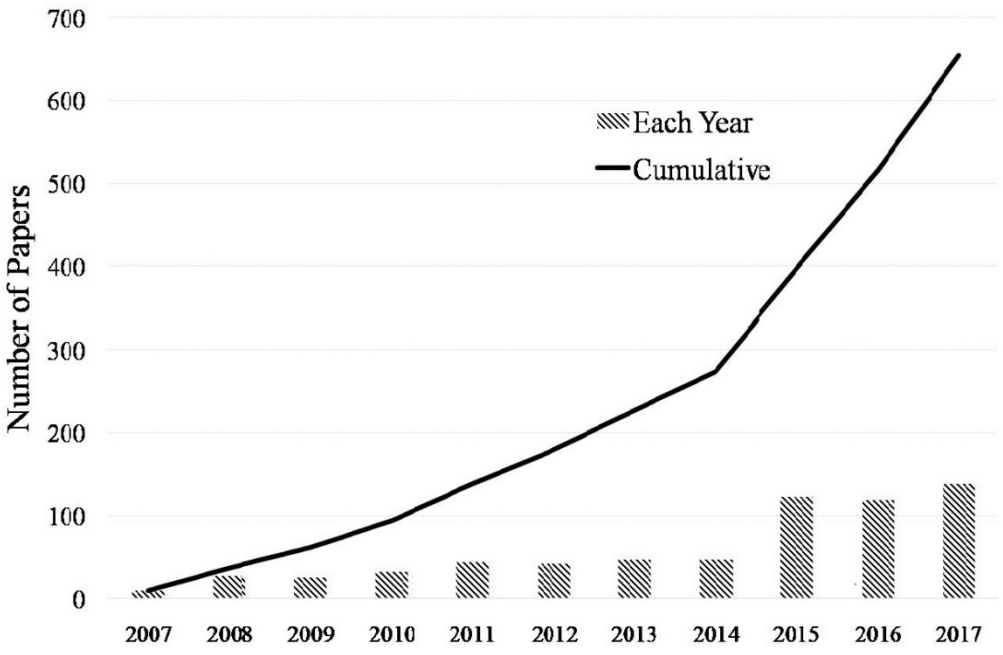

Figure 1. Telerehabilitation yearly and cumulative publications.

With the explosion of telerehabilitation research, we could assume we are on the verge of great changes in the way in which we practice therapy in the context of physical rehabilitation. However, while there have been interesting studies that test the efficacy of various telerehabilitation interventions (using a large variety of prototype and off-the-shelf technological devices), there has been little discussion on the mechanism of implementation of these telerehabilitation interventions. The variety of implementation strategies and technological devices applied in different stages of care with different patient populations is enormous. If even a small proportion of tested protocols were implemented in clinical practice, it would represent a sea change in how physical rehabilitation services are delivered and how patients interact with the health care system.

2. The 'wicked problem' of telerehabilitation

Telerehabilitation research and care is driven, in part, by the continuous introduction of

relatively affordable technology into the hands of consumers and health care systems. Fundamentally, telerehabilitation works to address a fundamental question: how to improve access to rehabilitation services for patients, in an efficacious, cost-effective, and safe manner? Research on barriers to access of physical rehabilitation for different patient populations are in agreement that lack of available services in the community, transportation barriers, conflicting time schedules, comorbidity, lack of available health human resources, and disease severity or acuity all impact an individual's ability to access and attend conventional rehabilitation programs [6–8]. The potential of telerehabilitation to reduce barriers and improve care is enticing. However, much of the research to date has not explored the impact of the introduction of telerehabilitation on a systems level, incorporating data beyond efficacy in the planning and implementation.

In many ways, the challenge of introducing a complex intervention such as telerehabilitation has many elements of a 'wicked problem'. What is a wicked problem? Urban planner Horst Rittel created the term to describe problems that are complex, challenging, and intricately linked with the social and political contexts in which they occur [9,10]. How might telerehabilitation be considered a wicked problem? To answer this, it is helpful to consider rehabilitation care from the perspective that places the individual patient in the context of influences from the intervention itself, the provider, and the system. As such, the provision of telerehabilitation services represents a complex intervention. Each of these factors has the capacity to influence the success of the telerehabilitation system as a whole, and changes to one factor may influence others.

Christensen et al. [11], in their paper on disruptive innovation, comment that most technologies, however novel, fundamentally work to sustain the functioning of the current system. Current health systems, in any country, are complex and have many embedded elements that are not always easy to define or change. However, when considering a new intervention that has the potential for a large-scale disruption in how rehabilitation is delivered, some of those hidden elements should be considered, articulated, and examined for the potential impact on them. Therefore, the purpose of this paper is to explore how the intervention, the patient and the system contribute multiple elements of a wicked problem that need to be considered for the successful implementation of telerehabilitation.

3. The intervention

Typically, telerehabilitation falls into two main modes of delivery. The first mode is remote and/or web-based rehabilitation. In these types of programs, the patient is provided with a rehabilitation schedule of exercise, education and behaviour modification activities which they do unsupervised at a time that is convenient for them. The patient and/or their family member keeps track of various parameters, which are then communicated to the rehabilitation professional via teletechnology. This teletechnology may include text messaging, entering data on a website, or following up with telephone calls from the patient or the health care professional. The rehabilitation intervention is therefore dysynchronous with the interaction with the health care professional. The second mode of telerehabilitation involves real-time interaction via video-conferencing or similar communication, and is synchronous, in that the patient undertakes the task under the direct, real-time supervision and communication with the health care professional. This real-time communication may be one-to-one, or in a group setting. Regardless of mode, certain principles of telerehabilitation delivery should be in place. A study

by Kairy et al. [12] suggested that telerehabilitation should (1) improve access to service while reducing transportation; (2) enable the development of a strong therapeutic relationship with the therapist; (3) have both in-person and telerehabilitation visits; (4) have standardized yet challenging exercises; (5) support the ease-of-use of equipment; and (6) provide ongoing support.

To date, research on telerehabilitation has primarily focused on the efficacy and feasibility of providing the service, typically within the rigorous confines of clinical trials or feasibility studies. Trials and systematic reviews have explored the impact of telerehabilitation in several patient populations, including patients with stroke [13], cardiac disease [13,14], post-orthopedic surgery [13,15], chronic obstructive pulmonary disease [16], and arthritis [5]. Unfortunately, many of these studies have had small sample sizes, are extremely heterogeneous in the delivery of the intervention (which is expected in the early stages of technology development), and suffer from various sources of bias, which has made synthesizing the findings within and across patient populations difficult. For example, while systematic reviews of cardiac telerehabilitation have reported positive results on motor function and exercise capacity outcomes [13,14,17], in stroke telerehabilitation one systematic review suggested the evidence showing benefit on motor function was inconclusive [13], another stated stroke telerehabilitation offered similar benefits of motor function, activities of daily living, and quality of life compared to usual care [4], and a third suggested stroke telerehabilitation offered greater benefit than usual care [18]. Clearly, research on telerehabilitation is in its infancy, and the tendency to publish positive results hamper our ability to understand what aspect, and for whom, telerehabilitation may be beneficial. Indeed, there are many questions that have not been resolved when designing these studies, including: (1) what is the appropriate control group? Should it be participants who are in 'traditional' hospital-based rehabilitation, or participants who receive no rehabilitation (i.e., usual care)? Further to this comment, should the comparison studies be conducted as superiority trials or non-inferiority trials? Non-inferiority trials are more complex to design and analyse, and it may be difficult to synthesize study results from studies with different designs and analyses; (2) what is the appropriate patient population? Should it be anyone who would normally be referred to 'traditional' pulmonary rehabilitation, or should we recruit individuals with an expressed interest, skill set, or capacity to be in telerehabilitation? and (3) is a simple randomized study design appropriate, or should we be considering mixed method approaches that incorporate quantitative, qualitative, and economic data collection and analysis? Indeed, Rittel [9] argues that the scientific method of clinical trials may not be appropriate to address a complex intervention (such as telerehabilitation), as by nature a clinical trial can only really examine one element at a time while holding other aspects equal, whereas there may need to be a more detailed exploration of the interplay of the many complex variables to fully understand the impact on health outcomes.

4. The patient

The need for rehabilitation services is increasing, due to aging of the population and the increased prevalence of chronic disease or dysfunction. The World Health Organization estimates that more than one billion people in the world today have at least one long-term disability, and that 15.6% of the population aged 18 years and older experience significant functioning difficulties in their day-to-day lives [19]. Patients bring many skills, attributes, and attitudes to the rehabilitation setting which are influenced by age and socioeconomic status. These factors

influence the telerehabilitation care environment and can impact their health outcomes.

4.1. Skills and interest

Early concerns of telehealth were that many patients who attend rehabilitation programs are older and may not be using, or have the capacity to use, the technology required to deliver telerehabilitation. This perception was reflected in market surveys of smartphone and computer use and confidence in older adults. In 2013, the Pew Research Center [20] conducted a survey of 1,526 adults 65+ years living in the United States and found that just 18% of respondents owned a smartphone, although 59% of respondents were Internet users. A later Pew Research Center survey [21] of older adults conducted in 2016 found that while smartphone ownership among seniors had increased substantially, only 26% of seniors were "very confident" when using computers, smartphones or other electronics, compared to 74% of younger adults.

In addition to owning and using technology, people must also wish to include it in their health care. In general, patients see a role for technology and digital devices. A 2017 survey [22] of 2,500 patients from the United States found that 64% of patients report using a digital device to manage their health and 71% of patients feel the information collected by a device should be made accessible to their doctor and be part of their medical history. Two thirds of seniors surveyed want telehealth technology in order to access care from home; support self-care; monitor symptoms; engage in online communities; navigate health needs; and record health information [23].

Telerehabilitation is a unique facet of the telehealth arena, as it moves beyond telehealth monitoring and communication to active patient and therapist participation in the rehabilitation process, with less direct therapist-patient interaction than what is typically provided. Whether or not patients want to receive rehabilitation services via tele-technology is unclear. Rehabilitation is long-term, complex, and intensive, and there is a need to develop a robust therapeutic relationship between patient and health care provider in order for optimal results to be obtained. Edgar et al. [24] conducted a survey of individuals with stroke and found that although the majority of patients were interested in receiving specific types of information and exercise programs via telerehabilitation technology, almost 40% of patients believed the quality of care of telerehabilitation would be less than in-person rehabilitation. Alternately, Moffet et al. [25] compared satisfaction of patients who received in-home telerehabilitation compared to those who received face-to-face home visits, and found equal levels of satisfaction with the care received (85% positive) with no association with personal characteristics or physical improvement. Satisfaction with telerehabilitation services is likely dependent on how questions are asked, the patient population, the specific telehealth intervention (such as real time video-conferencing, group-based or one-on-one, remote biomonitoring) and the existing availability of health care services in the community. In communities where no rehabilitation service exists, any type of rehabilitation may be considered better than no rehabilitation at all.

4.2. Financial security and access to technology

Equity in smartphone, computer and internet access is an important consideration when designing telerehabilitation programs. Although in 2016 42% of adults aged 65+ years owned a

smartphone this proportion drops to 27% when surveying adults in the lowest income bracket [21]. Many telehealth studies provide the equipment required which was subsequently removed at study end, so the issue of access is not addressed. Broadband internet and adequate cellphone coverage in remote locations is not 100%. Rehabilitation requires resources that may not be available to a person outside of the health care setting, such as printed documents or exercise equipment. In the research literature, there has been less discussion about "who pays" for equipment and if patients with less financial security may have decreased access to telehealth services.

4.3. Health and safety

In general, telerehabilitation efficacy studies have been largely positive, although it is well-recognized that negative studies are difficult to publish [26], and data on adverse events are rarely reported. There has been little examination of whether certain patient populations are more appropriate for a telerehabilitation intervention although there have been warning signs that safety may be a concern. For example, Fan et al. [27] conducted a study of 426 patients who had been hospitalized for an acute exacerbation of COPD within the previous year. They implemented a case management program which included action plans for patients to follow which helped them identify and seek care related to future exacerbations, and regular phone calls from the case manager. There was a substantial increase in mortality in the intervention group, which could not be explained with the existing data. Although one editorial [28] on this paper raised the possibility that this was a chance finding, others [29] suggested that although there was regular scheduled contact with a health care professional the patient may not have initiated contact and not sought emergency help when they had symptoms of an exacerbation. In telerehabilitation, patients need to know how to recognize an adverse event and be supported to activate an action plan. These adverse events may potentially be serious (e.g., an adverse hemodynamic response to exercise) or mild (e.g., muscle soreness after exercise). The mechanism for regularly enquiring about, documenting, and acting on any safety concerns must an integral part of the program.

4.4. Behaviour, adherence and novelty

The current rehabilitation system relies on a medical model of care, where medical (health) experts conduct an assessment, make a diagnosis, and provide ongoing care and monitoring which is received by the patient. Although active participation is required, and a patient-centered model is espoused, rehabilitation care is typically delivered as decided by the health care providers. Tele-rehabilitation relies on an increased responsibility on the part of the patient, and perhaps a higher need for the patient to be motivated to participate in the ongoing care and monitoring. Rehabilitation that uses teletechnology devices may be uniquely positioned to provide incentives to motivate patients to more fully participate in their rehabilitation. For example, different wearable devices for activity enable the use of ongoing self-tracking; comparing results with a cohort of participants; 'rewards' that are unlocked when levels are reached; games; and the ability to communicate with a wider social network. These incentives reinforce the expected behaviour of patients to take an active role in their rehabilitation care, and

for the patients to see firsthand how the data changes over time. The "quantified self" is a term relating to the collection of data by an individual on their own biological, physical, behavioural or environmental characteristics and has given rise to interest groups (i.e., www.quantifiedself.com) and research scholarship (e.g., work by Deborah Lupton [30,31]). Lupton provides a critical analysis of the use of technology for self-surveillance and feedback, including how 'healthism' (the pursuit of good health over other aspects of life) may be supported by information that comes to us via technology (such as wearables and other biomonitoring equipment). Healthism seeks to shift the paradigm that good health is the responsibility of the physician to good health is the responsibility of the individual, and the monitoring and communication that is required of telerehabilitation enforces that expectation.

Although patients are interested in the use of technology to delivery health care services, there are challenges with long-term adherence as the novelty factor with new technology fades quickly. Eighty percent of downloaded apps on smartphones are never used after a 3 month period [32]. A 2015 US survey published found that although fitness and nutrition apps were the most commonly-downloaded health apps among the sampled population, almost half of the respondents had stopped using the app for various reasons, including high cellular data use, loss of interest, and hidden costs [33]. However, there may be a segment of the population for whom using apps and tracking health behaviour may be a good fit. Rasche et al. [34] examined the prevalence of health app use among older adults with at least one chronic disease. They found that while only 16.5% used a health app, most used these apps on a weekly basis, and most apps were related to exercise. Users tended to be younger and reported being more comfortable with their technology.

Adherence has also been specifically examined in the telerehabilitation setting. In a recent study [35] on web-based telerehabilitation in patients with COPD, the drop-out rate in the telerehabilitation group was 57% compared to 23% in the traditional rehabilitation group. The investigators explored the reasons and found that those with anxiety prior to the trial who were allocated to the telerehabilitation group were more likely to drop out, and that most dropouts occurred early in the program, suggesting that some patients may not be good candidates for this intervention, and/or need additional support in order to be successful. In a separate study of synchronous telerehabilitation in individuals with heart failure [36], participants attended real-time online rehabilitation sessions in small groups and adherence was much higher at 96%. Likely, there needs to be an additional commitment by both the patient and the provider to maintain the therapeutic relationship in a synchronous application that is without the benefit of a live-person voice and visual communication.

5. The system

While the research to date has focused on the efficacy of the intervention and the impact on the participant, less attention has been paid to the impact of the introduction of telerehabilitation on the health care professional and the health system at large, despite their contributions to the 'wicked problem' of widespread telerehabilitation implementation. However, there are several key issues that must be addressed going forward.

Several studies have examined the perspectives of health care professionals involved in telerehabilitation programs. Inskip et al. [37] conducted focus groups with physical therapists,

respiratory therapists and a nurse involved in pulmonary rehabilitation and found that maintaining the social aspect of pulmonary rehabilitation, communication between patients and providers, using biosensors for monitoring, and changing the nature of support (from more to less intensive over time) were key factors in providing telerehabilitation. The health care professionals also voiced concerns that telerehabilitation responsibilities would be added to their regular caseload (which could lead to burnout), but also stated they wouldn't want to be solely involved in telerehabilitation programs—they needed the interaction of traditional rehabilitation for their own job satisfaction. Similarly, physical therapists who participated in an Australian survey [38] about telerehabilitation for neurosurgical or orthopedic patients agreed that although telerehabilitation would improve access to care, they believed increasing service would increase waitlists unless more resources were added. They also said that patients would lose the hands-on practice of physical therapy which may negatively affect their health outcomes. Health care professionals also considered the need for an additional professional in the health care system, that of an IT support person, in order to ensure that the potential efficiencies of telerehabilitation are not negated by lack of IT support.

Although the requirements for successful implementation of telerehabilitation have not been determined, work from the telehealth field in general may provide some guidance. Vassilev et al. [39] conducted a review of telehealth interventions and concluded that three core mechanisms were necessary for a telehealth intervention to be successful. The first of these mechanisms was *Relationships*, which needed to be established between the patient and the provider, in order to provide support and reinforce positive behaviour change. They noted that if the intervention alters the traditional relationship dynamic, then other mechanisms to establish a supportive relationship may be necessary. This may be as simple as a telephone call or video-conference in order for the patient and provider to talk with each other in real-time. The second mechanism of a successful implementation was *Fit*. In the context of telerehabilitation, it is important for the telerehabilitation to be easily integrated into the patient's day-to-day life, and the authors suggested that simple technologies appeared to be as successful, or even better, as more complex ones, and that telehealth interventions that were compatible with existing systems were more likely to be implemented. The patient also had to see the ongoing benefit of continued participation. The final required mechanism involved *Visibility*. By participating in a telehealth intervention, such as telerehabilitation, patients have access to more information about symptoms and biomonitoring information (such as blood pressure, peak airflow, oxygen saturation, or blood glucose levels) which has the capacity to increase their knowledge and support positive behaviour change. This work was supported by a 2016 paper by Ross et al. [40] who explored the factors associated with implementation of e-health. They also reinforced that implementation does not occur one time when creating a system, but that there needs to be ongoing monitoring, evaluation, and further re-adaptation to ensure the system is performing as intended.

While health care has always involved relationships between the patient, the provider, and industry, new players in the health care system are the smartphone companies, the internet and cellular phone providers, and private telehealth companies. Access to some services may require their partnership (such as providing cellular phone coverage or broadband internet) and therefore decisions on access to services may shift outside the jurisdiction of the health care system. The roles, responsibilities (including security of patient information) and liabilities (for example, if a biomonitoring device malfunctions) have not been critically reviewed.

There has been little examination of the policy implications of telerehabilitation. Traditional rehabilitation care typically involves the patient and provider interacting within the same physical space. In telerehabilitation, where the patient and provider are communicating at a distance, issues arise relating to the liability of the providing institution, how to handle cross state or provincial border care, and how to provide rehabilitation services where different health care professionals within rehabilitation may have different governing practices. In the United States, the Department of Veterans Affairs, a national health care system, recognized the challenge of supporting telehealth services to its beneficiaries while recognizing that VA clinicians who provide telehealth to patients who reside in states in which the clinicians do not have a license to practice run the risk of fines and criminal charges for unauthorized health care delivery [41]. This was only just resolved on June 11, 2018, whereby the final rule enables VA providers to provide the same level of care regardless of location or state laws to the contrary. In Canada, a memorandum of agreement (MOA) [42] between the physical therapy colleges of 10 provinces was signed which enabled the provision of physical therapy services where the therapist resides in one province but the patient lives in another. However, the MOA requires that the physical therapist hold licensure in both provinces which is unlikely to be realistic for most therapists. For many rehabilitation professionals, their employer is the hospital who carries liability insurance on their behalf for care of patients admitted to that facility. Therefore, for telerehabilitation to exist in many current health care systems, the patient would need to be 'admitted' to the institution where the therapist practices even if they live in another jurisdiction. This may require at least one in-person visit, which may negate some of the benefit of telerehabilitation as being a distance-provided intervention.

Payment for telerehabilitation services by patients, health insurers, or employers have not been adequately explored in the research or policy literature. It is beyond the scope of this article to explore payment for telerehabilitation services and cost-effectiveness of telerehabilitation versus traditional rehabilitation, given the diversity of rehabilitation interventions coupled with different health care funding mechanisms between and within countries, but nevertheless it warrants a comment that if telerehabilitation moves the care out of the health setting into the patient's home or community, at least some of the equipment and other resources that supports rehabilitation care will be moving as well. This is especially apparent when one considers equipment such as smartphones which have the capacity to support the assessment, monitoring and communication of information between patient and provider. While some research studies have provided teletechnology equipment as part of the study, it is possible that the burden of payment related to technology may be borne, at least in part, by the patient. Given the spread of teletechnology in society, this may not be a barrier to the provision of telerehabilitation, but nevertheless the potential shifting of responsibility of the provision and maintenance of the equipment needs to be considered.

In summary, there are many potential benefits (and numerous challenges to address) related to the implementation of telerehabilitation (Table 1). Future research should focus not only on the efficacy and safety of a given intervention for specific populations, but on exploring why a particular telerehabilitation program is beneficial (or not), using mixed methods research designs. Implementation studies should confirm that the proposed program addresses the factors which have been identified for successful implementation of telehealth interventions, and contribute to the list if there are telerehabilitation-specific issues to address. Economic analyses which detail

costs of all the elements of telerehabilitation for the patient, the providers, and institutions, the technology industry, and the health care system as a whole are also necessary and likely would need to be conducted at a regional level.

Table 1. Expected benefits and potential benefits of telerehabilitation.

Expected benefits	Potential barriers
↑ convenience for patients	Efficacy not established for many clinical populations
↑ access for patients	Loss of group effect
↓ travel needs	Safety not reported in many studies
Integration of exercise into day-to-day life	Optimal patient characteristics not identified
Patient empowerment	Training requirements for patients, family and providers
Coordination of care amongst team members	Teletechnology may need frequent updating
Rapid monitoring and flagging of health problems	Need for high-speed connectivity if streaming video or video-conferencing
May facilitate ongoing maintenance behaviours	Large geographic areas to cover
Communication improved between patients and providers	Reimbursement and legal issues have not been clarified

6. Conclusion

Telerehabilitation holds much promise as a health care intervention but the heterogeneity of the interventions, the limitations of current research designs to explore multiple variables simultaneously, the rapid development of technology, and the myriad of jurisdictional, payment, and access issues currently render the implementation of telerehabilitation as a 'wicked problem' with many aspects to refine. A structured, systems approach to explore the interwoven elements of the intervention, the patient, and the health care system as a whole is recommended.

Conflict of interest

The authors declare no conflict of interest.

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