Celian *et al. J NeuroEngineering Rehabil (2021) 18:121*
https://doi.org/10.1186/s12984-021-00911-6

a variety of measurement and therapeutic RTs to aide in their delivery of evidence-based rehabilitation. The field of neurorehabilitation engineering faces numerous challenges with translating new RT into everyday practice at all stages of development and implementation. Successful application of therapeutic RT requires development, testing, validation, clinician uptake, and patient acceptance.

There are several benefits of incorporating RT into therapy. RT can enable therapists to achieve tasks that are difficult or impossible to do without RT, such as lifting a heavy patient or measuring physiological variables [2]. RT can enable patients to achieve a higher number of movement practice repetitions, a necessary element of neuroplasticity during recovery [3, 4]. RT can increase motivation for therapy by providing physical assistance that allows patients to attempt and complete movements [5–7] or by incorporating gaming environments and quantitative feedback [8]. Finally, it can also reduce the need for providing continuous physical assistance or supervision to a patient, which can increase productivity or can increase patient access to therapeutic training [9].

Despite the observed benefits of RT, clinicians report barriers to their practical application. Barriers can arise from multiple domains such as the patient, the clinician, or the rehabilitation context [10]. Patients themselves can reject RT in favor of conventional therapy or have cognitive deficits which inhibit their participation [4]. Clinicians question the effectiveness strength and clinical necessity of the device [4]. Within the clinical setting, devices sometimes are too large and bulky to adapt use within an organization [11]. Clinician use is also influenced by institution facilitation of use, organizational culture and intention of use [2]. Outside clinical setting barriers also exist when a device is unavailable to the patient post-discharge [10].

Research suggests that clinicians function as gatekeepers to promote the implementation of new interventions [12]. The process for adopting RT into the clinic must undergo intense scrutiny before uptake including the clinical applicability, cost–benefit analysis, and safety of the device [13]. Therefore, it is vital to determine the gaps between the theoretical benefits and the practical application of such RT that would enable clinician uptake. Several previous studies have used survey methods [10, 14] or focus groups [4] to identify these gaps, but such approaches may not fully capture the real-time, pragmatic decision making that therapists must engage in during treatment sessions. Our approach here combined implementation science methodology to help make research more generalizable. Our premise is that integrating implementation science with neurorehabilitation engineering can accelerate the future integration of novel RT.

Our purpose is to describe clinician decision-making around incorporating RT into treatment sessions to improve understanding of clinician uptake, the critical step to device implementation. To provide a window into a day-in-the-life of clinician and the decision-making during a typical treatment session, we had OTs and PTs write vignettes describing a treatment session, along with their thought processes. Then we synthesized the vignette data using an implementation science framework, the Consolidated Framework for Implementation Research (CFIR), a common implementation framework *provided these instructions… e patient responded in this way… I chose not to use tools because… It worked/did not work because…*

Analyses

We used deductive qualitative analysis to identify codes in the provided vignettes related to barriers to RT use and knowledge translation identified in literature [10, 14, 16]. We named these barriers using the CFIR framework, which explains 39 implementation constructs across 5 domains. ese constructs can be barriers or facilitators, making implementation more or less di cult, respectively [15]. e codebook (Table 1) contained 15 original CFIR constructs identified in prior research [10, 14, 16]. Two constructs were added to distinguish between the attributes, knowledge and beliefs of clinicians compared to patients.

 ree reviewers coded each vignette in their entirety, but the vignettes are presented in a summarized form to follow the template more concisely and provide novel information. e full, unedited vignettes are available upon request. Summative content analysis included used the total number of codes presented, and the proportion of times each code was used across clinicians and vignettes [17]. is qualitative analysis plan provided a systematic method to synthesize the vignette results.

Results

 e constructs, their definitions, and results of summative content analysis are presented in Table 1.

Nine vignettes provided by five therapists detail experiences with patients with the following diagnoses: traumatic brain injury (n = 2), SCI (n = 1), stroke (n = 4), and multiple sclerosis (n = 1). Six vignettes were provided by OTs. ree vignettes were provided by PTs. All therapists have at least 4 years of clinical experience and have assisted with research projects in the past. e 17 codes (listed in Table 1

Table 1

Table 1 (continued)

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CFIR domain	Construct*	Definitions*	Number of clinicians (of 5) & number of vignettes (of 9) mentioning (%)	Total number of times mentioned (% of 174 total mentions)	Exemplar quotes**	
					Facilitators	Barriers
Inner setting (organization)	Patient needs and resources	The extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately known and prioritized by the organization	4/5 (80%) 6/9 (66.7%)	14 (8.0%)	"When it was time for him to leave, I provided him with information to get a cycle for home through the vendor that we had worked with, as she mentioned that she may be able to get him a cycle for a discounted rate since he was in the military."	"Finally, the patient's wife is present and is very anxious, providing too many cues to the patient, overwhelming him and expressing disappointment with his performance."
	External policy	A broad construct that includes external strategies to spread interventions, including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting	3/5 (60%) 3/9 (33.3%)	5 (2.9%)	[none coded]	"…how do I balance what is required vs what is ideal (required insurance tasks, progress updates, outcome measures, what has the patient already done for the day, what is recommended best available evidence for the interventions that address their goals)." (relative advantage, intervention evidence, patient attributes)
	Readiness to implement	Tangible and immediate indicators of organizational commitment to its decision to implement an intervention	4/5 (80%) 5/9 (55.6%)	12 (6.9%)	"[the vendor] was able to come to a co-treatment with the patient and I to help me with optimal setup."	"It had been a while since the 2-h training session that I went to …"
	Overall implementation climate	The absorptive capacity for change, shared receptivity of involved individuals to an intervention, and the extent to which use of that intervention will be rewarded, supported, and expected within their organization	5/5 (100%) 5/9 (55.6%)	6 (3.4%)	"…is integrated as part of the new hiring system …. In my experience, learning to correctly use the machine has not been any issues after initial training/mentoring." (readiness to implement)	"My colleague and I both lacked confidence and did not want to use normal therapy time to test out the device, but we decided to treat patient pro bono after clinical hours to setup and run through with the device to improve familiarity." (external policy, clinician attributes, clinician stage of change)
	Culture	Norms, values, and basic assumptions of a given organization	2/5 (40%) 2/9 (22.2%)	3 (1.7%)	"… appeal for "sexy" technology …"	"As an OT, we are taught 'function, function, function!', and this sentiment is reinforced by our professional organizations, and therapy leaders, that patient goals, daily interventions and treatment plans should address improved function."
Process of implementation	Executing	Carrying out or accomplishing the implementation according to plan	2/5 (40%) 2/9 (22.2%)	4 (2.3%)	"…we were assured that although the initial use would be confusing, consecutive uses become efficient."	"My confederate therapist and I could not coordinate another time to practice on the new device…"

*See https://cfirguide.org/constructs/ for full definitions of each code

**Where applicable, quotes that were double coded are noted in parentheses

attributes of the patients, clinician knowledge/beliefs, device complexity (including time and setup), and organizational readiness to implement.

Relative advantage

e most discussed barrier to using RT was its perceived

Acknowledgements
We thank the clinical sta at the Shirley Ryan AbilityLab that generously allowed some of their spare time to construct these writings and views. We also thank the Robotics Lab at the Shirley Ryan AbilityLab and the members of the STARS RERC and COMET-RERC.org for their ongoing comments and advice.

Authors' contributions
This project was conceived by JP, CC, MR, and DJR. Data collections were completed by CC. Data analyses were conducted by MR, CC, and VS. JP, MR, CC, VS, and MS wrote the manuscript, with critical review and edits completed by CC, VS, MS, CN, BFK, SG, KR, and DJR. All authors read and approved final manuscript.

Funding
This work was supported under Grant 90REGE0010 and 90REGE0005-01 from the U.S. Department of Health and Human Services, Administration on Com-