

Intensity: What Rehabilitation Technology Can Add to the Subject

Neurol Rehabil 2017; 23(1): 53–56
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Abstract

Evidence more and more supports the notion that higher intensity training also leads to better outcomes in neurorehabilitation. However, current practice shows that for many reasons, it is challenging for health care professionals to deliver such high intensity training. Rehabilitation technology can be one important factor to help overcome those barriers and to provide to our patients the intensive therapy they need and deserve. It is, however, crucial that those devices are well integrated into the clinical every day practice, well combined with traditional therapy and that reimbursement questions are solved. The work is cut out for us, let's all get to work, for the benefit of our patients!

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Keywords: rehabilitation technology, efficiency, intensity, optimal use, clinical integration

Neurological injuries and rehabilitation

Damage to the neurological system, as a result of illness or injury, affects over a billion people worldwide [44]. This damage can, among other consequences, lead to motor impairment which necessitates rehabilitative treatment. Rehabilitation has been defined by the World Health Organization (WHO) as an *»active process by which those affected by injury or disease achieve a full recovery or, if a full recovery is not possible, realize their optimal physical, mental and social potential and are integrated into their most appropriate environment«* [43] (emphasis added by the authors). Literature shows that intensive training is required to exploit the full potential of recovery. There is in fact overwhelming evidence that more intensive training leads to better rehabilitation outcomes, for example in individuals with stroke [3, 10, 13, 14, 16, 18, 19, 22, 25, 34, 38, 40], and reduces hospital readmission rates [1].

Situation today: Length of in-, and outpatient rehabilitation

Today, however, the clinical reality looks rather different. Financial pressure can be felt everywhere since only little money is designated for rehabilitation. For example, in Switzerland, in 2014, only 1.7% of total health costs were attributed to inpatient rehabilitation. Outpatient physical therapy only added up to 1.4% of the total health costs [4].

This leads to the fact that many individuals with motor impairments are discharged from inpatient rehabilitation considerably short of attaining their optimal potential. Rather than receiving therapy until their potential is reached, they are discharged when it is

considered safe by the third party payers [17]. Reduced reimbursement for inpatient rehabilitation drives rehabilitation to outpatient and home settings. This, in turn, led many insurance companies to establish caps on outpatient therapy services. In the United States for example, Medicare patients are entitled to outpatient physical therapy services of \$1980 per year [29]. Single physical therapy sessions amount to approximately \$100 per session. These numbers are representative for many parts of the world. Therapists and patients are thus forced to compromise when it comes to goal setting and patients do not recover to their optimal rehabilitation potential.

Situation today: Therapy time per day during rehabilitation

Actual therapy time during a regular day at a rehabilitation hospital is generally very limited. This is mostly due to management decisions, lack of structured organization and inefficient use of resources [6, 7]. In four European rehabilitation centers, individuals with stroke received between one and three hours of therapy per day, yet, over 72% of the day was spent on non-therapeutic activities [6]. This has consequences, as these authors were also able to show that patients in centers with less therapy time per day have less functional recovery than those who are treated in centers that provide more therapy time per day [7].

Situation today: Number of repetitions within a therapy session

In addition, during a session of conventional therapy, dosage is generally rather low, even during inpatient rehabilitation. For example, Hayward et al. describe that

Intensität: Was Rehabilitationstechnologie dazu beitragen kann

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Zusammenfassung

Klinische Evidenz zeigt je länger je mehr, dass intensiveres Training zu mehr funktionellen Verbesserungen führt, auch in der Neurorehabilitation. In der heutigen klinischen Praxis erweist es sich für die behandelnden Kliniker aber als äußerst schwierig, den Patienten die nötige intensive Therapie zukommen zu lassen. Rehabilitationstechnologie kann dazu beitragen, diese Schwierigkeiten zu überwinden und den Patienten die intensive Therapie zukommen zu lassen, welche sie benötigen und verdienen. Hierbei ist es aber ungemein wichtig, dass die Geräte gut in den Klinikalltag integriert und ideal mit der herkömmlichen Therapie kombiniert werden. Außerdem müssen Fragen der Kostenübernahme geregelt werden. Lassen Sie uns zum Wohle unserer Patienten alle zusammenarbeiten, um diese Hürden zu überwinden!

Schlüsselwörter: Rehabilitationstechnologie, Effizienz, Intensität, optimaler Gebrauch, klinische Integration

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the dose of activity-related arm training only adds up to an average of 4 minutes and as little as 23 repetitions per therapy session during inpatient rehabilitation [12]. Lang et al. found an average number of repetitions per session of 32 for the upper extremity and of 357 for the lower extremity [20].

Individuals post stroke also make significantly less use of their upper extremities throughout the rest of their day during inpatient rehabilitation. Whereas able-bodied control persons use their arms during 8-9 hours per day, individuals with stroke, during inpatient rehabilitation, use their more affected arm during only 3.3 hours and their less affected arm during 6 hours per day [21]. This non-use leads to negative plasticity and further impairment [36].

So, while it is certainly possible to intensify therapeutic treatments during inpatient rehabilitation [3, 7], it is challenging for many reasons and often not done.

Rehabilitation outcomes and associated costs with limited intensity of therapy

Needless to say that this suboptimal amount of therapy provided results in large amounts of untouched recovery potential. Out of the roughly 15 million people worldwide who experience a stroke each year, 5 million live with permanent disability [44]. The Framingham study, for example, showed that of all stroke survivors, 20% remain dependent in their mobility [11]. Clearly, this dependency, as well as other under-treated impairments, lead to tremendous costs throughout the person's lifetime [15, 23, 28, 37, 46].

For Medicare users in the United States for example, while mean rehabilitation length of stay after an acute stroke was only 14.6 days, readmission rate to the hospital was 12.7% within the first 30 days after discharge from rehabilitation [32]. And it is self-evident that readmis-

sions are associated with high costs. In Europe, the total cost resulting from stroke (direct medical cost, direct non-medical costs and indirect costs) was €37.4 billion in 2010 [27].

There is a desperate need for affordable solutions to provide our patients the intensity of therapy necessary to optimally exploit their potential for recovery during inpatient, outpatient and home-based rehabilitation stages.

Rehabilitation technology as a solution to the intensity problem

Including advanced technology as a complement to the daily therapy routine is one way to reach high training intensities [9, 24]. These devices take the physical burden off the therapists, thus allowing training duration to be limited by the patient's capabilities rather than by the physical fitness of the therapists. With the assistance of such devices, participants in one study performed almost 900 functional arm movements per session [33]. Another study describes an individual with spinal cord injury walking distances of up to 2 kilometers (roughly 3,300 steps) per session [35].

In a recently published study, individuals with clinically motor complete, chronic spinal cord injuries reached surprising results thanks to intensive, long-term gait training. In these patients, locomotor training without technological support would have been an extreme physical burden on the therapists. Thanks to technological support however, they were able to intensely train over a period of 12 months and reach surprising results. These patients with severe, chronic injuries not only improved in the Walking Index for Spinal Cord Injury (WISCI), but half of the patients also were classified as clinically motor incomplete as result of the intensive training [8].

Another benefit of technology-assisted therapy is that patient supervision can be reduced considerably [45]. If patients don't need constant one-on-one supervision thanks to rehabilitation technology, a single therapist can supervise several patients at the same time, which frees the therapists' capacities and allows individual patients to train longer. A currently ongoing study is investigating whether increasing therapy time by having one therapist supervise two patients who train with an arm exoskeleton and thus allowing them twice as much therapy time, will lead to better results than if each patient receives the regular amount of one-on-one supervision (personal communication). Another study is currently investigating the possibility of after hours and weekend training with limited supervision. Patients are given the opportunity to use an upper extremity device in the evenings after regular therapy hours and on weekends. The slightly modified device software allows therapists to define device setup and training program

for each patient ahead of time and patients can then be supervised by trained lay persons during their training. Preliminary data show that patients do take advantage of this opportunity and that they are increasing their therapy time considerably (Liepert et al. ongoing work, personal communication).

This last study especially is a wonderful example of how rehabilitation technology can be used to complement standard therapy in an efficient and effective way.

Improved clinical outcomes thanks to rehabilitation technology

Thanks to its benefits, technology-assisted training has garnered considerable attention over the past years. This is reflected in a large number of published research studies. Numerous individual trials and several systematic reviews [5, 26, 39, 42] have shown the positive effects of robotically assisted gait training, and of technology-assisted training of the upper extremity [2, 5, 26, 42]. Cochrane Reviews showed that every fifth gait dependency could be prevented if patients received electromechanically assisted gait training in addition to their regular therapy program [30] and that electromechanical and robot-assisted arm training led to improvements in activities of daily living and arm function [31] in individuals post stroke. Similar to physical therapy in general, it was also shown for technology-assisted gait training that more intensive training programs lead to improved outcomes [41].

All these studies have shown that it is in fact possible to improve outcomes through intensifying training paradigms with the help of rehabilitation technology.

Need for clinical integration

The aforementioned intensification has mostly taken place within a research environment and via corresponding reimbursements through grants or other sources. In order to show the effect under clinical, everyday conditions and reimbursement situations, efficient settings have to be integrated into rehabilitation institutes and their effect on patient outcomes and economic parameters have to be shown. Investing in new technologies to provide efficient settings and delivering high intensive therapy is currently the sole responsibility of healthcare providers. In many countries, it is not reimbursed either through support of investments or reimbursement by insurances. On the contrary, with certain reimbursement models, such as diagnosis-related groups, there is no financial incentive for rehabilitation institutions to invest in such therapy models and provide more therapy for their patients.

It is therefore crucial that all stakeholders (i.e. patients, insurance companies, healthcare providers, politicians and the rehabilitation technology industry)

start communicating and searching for solutions together for the benefit of our patients. Incentives have to be created so that reaching optimal functional outcomes, as required by the WHO, rather than lower direct costs of inpatient rehabilitation are rewarded.

But reimbursement is not the only stumbling block that needs to be removed in order to use rehabilitation technologies to their full potential. Factors that can be influenced by the healthcare providers directly also play a crucial role. In a non-representative survey using semi-structured interviews, one of the leading companies in rehabilitation technology gathered data from 32 leading rehabilitation centers in the world. The goal was to identify factors that would support effective and efficient integration of rehabilitation technology into everyday practice. The following factors were the most important:

- using a comprehensive approach including several readily available devices and combining them with standard therapy and/or group therapy
- well educated personnel and regular continued education sessions
- efficient settings where one therapist supervises several patients training on different devices
- efficient and well organized therapy planning, including infrastructure use and patient transport.

Call to action

This is a call to action. Let us all contribute so that we can increase therapy intensity. Let's use rehabilitation technology to its full potential and combine it optimally with traditional therapy for the benefit of our patients. In order to provide more intensive therapy to our patients, manufacturers need to continue improving devices and integrating feedback from users; healthcare providers need to think big and integrate these devices effectively and efficiently into their daily clinical routine; and politicians and insurance companies need to collaborate in order to come up with adequate reimbursement models for such improved therapy models. Our work is cut out for us; let's get moving!

Acknowledgements

We cordially thank *Dustin Brumley* for editing this piece. Further, we would like to thank all our partners for their continued efforts in helping to advance the field of rehabilitation technology.

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