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Advances in cognitive and motor network rehabilitation for post-traumatic brain injury patients.

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Introduction

Traumatic brain injury (TBI) is a leading cause of long-term disability, often resulting in deficits in both cognitive and motor function. Rehabilitation interventions aim to harness neuroplasticity and facilitate functional recovery by targeting disrupted neural networks. Recovery outcomes depend on the interplay between local synaptic reorganization, recruitment of alternative pathways, and behavioral adaptation. Understanding these mechanisms is crucial to designing therapies that effectively restore cognitive and motor abilities, enabling patients to regain independence and quality of life [1].

Motor rehabilitation following TBI emphasizes repetitive, task-specific training that engages residual corticospinal and subcortical circuits. Robotic-assisted therapy, constraint-induced movement therapy, and functional electrical stimulation promote synaptic strengthening and cortical remapping, facilitating voluntary motor control. Neuroimaging studies reveal that these interventions enhance connectivity within motor networks and encourage compensatory recruitment of adjacent cortical regions. Sustained practice and progressive challenge are essential to maximize activity-dependent plasticity and improve functional outcomes [2].

Cognitive rehabilitation complements motor therapy by targeting executive function, attention, working memory, and problem-solving. Computerized cognitive training programs and virtual reality (VR) environments provide engaging, adaptive tasks that stimulate prefrontal and parietal networks. Neurofeedback systems allow patients to monitor and regulate their own cortical activity, reinforcing functional connectivity and improving cognitive performance. Integration of motor and cognitive interventions enhances network plasticity, supporting improvements in complex daily activities that require coordination of both domains [3].

Adjunctive neuromodulatory strategies further augment rehabilitation. Transcranial direct current stimulation (tDCS) and repetitive transcranial magnetic stimulation (rTMS) applied to targeted cortical areas modulate excitability and potentiate synaptic plasticity. Pharmacological agents affecting dopaminergic and cholinergic systems may optimize synaptic responsiveness and enhance learning during cognitive and motor exercises. Multimodal approaches that combine behavioral, technological, and pharmacological interventions demonstrate superior outcomes compared to isolated therapies, highlighting the importance of integrated rehabilitation [4].

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Despite progress, challenges remain, including inter-individual variability in injury severity, lesion location, and responsiveness to therapy. Personalized rehabilitation plans guided by neuroimaging, electrophysiology, and cognitive assessments are essential to optimize functional recovery. Long-term monitoring and adjustment of therapy, combined with interdisciplinary collaboration among neurologists, therapists, and neuropsychologists, are critical for delivering effective, patient-centered care [5].

Conclusion

Cognitive and motor network rehabilitation after traumatic brain injury relies on targeted, integrated interventions that leverage neuroplasticity. Combining task-specific training, virtual reality, neurofeedback, neuromodulation, and pharmacological support promotes functional recovery and independence. Personalized, evidence-based rehabilitation strategies are essential to maximize outcomes and improve the quality of life for TBI patients.

References

1. Taverna S, Cammarata G, Colomba P, et al. Pompe disease: pathogenesis, molecular genetics and diagnosis. Aging (Albany NY). 2020;12(15):15856.
2. Meena NK, Raben N. Pompe disease: new developments in an old lysosomal storage disorder. Biomolecules. 2020;10(9):1339.
3. Unnisa Z, Yoon JK, Schindler JW, et al. Gene therapy developments for Pompe disease. Biomedicines. 2022;10(2):302.
4. Davison JE. Advances in diagnosis and management of Pompe disease. J Mother Child. 2020;24(2):3-8.
5. Keutzer JM. Establishing Pompe disease newborn screening: the role of industry. Int J Neonatal Screen. 2020;6(3):55.

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