Advances in Neurotrauma Research: Protecting and Repairing the Nervous System After Injury

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SESSION OVERVIEW

This session examines emerging approaches to neuroprotection and neural repair after traumatic nervous system injury, with particular emphasis on state-of-the-art neuromodulation and brain–computer interfaces (BCIs) intended to improve upper- and lower-extremity function following spinal cord injury (SCI).

LEARNING OBJECTIVES

- Describe experimental neuroprotective and reparative strategies following neurotrauma.
- Discuss transcutaneous spinal cord stimulation, deep brain stimulation, and rehabilitation-linked neuromodulation.
- Explain the potential of brain–computer interfaces and brain-controlled stimulation to support upper- and lower-extremity motor function.
- Differentiate preclinical, investigational, and clinical-study findings from established therapeutic efficacy.

KEY SCIENTIFIC TOPICS

Neuroprotection and repair: Multicenter studies are evaluating systemic modest hypothermia after acute cervical SCI. Other research explores cooling nanodrugs, kinase-targeted compounds (including TMP-316 in IND-enabling development), Schwann-cell transplantation, and Schwann-cell-derived extracellular vesicles.

Noninvasive spinal cord stimulation: The Up-LIFT program investigated transcutaneous spinal cord stimulation for hand and arm function after SCI. The presentation also identifies EMPOWER as a subsequent study focused on symptomatic blood-pressure instability.

Deep brain stimulation and locomotion: Preclinical work investigated deep brain stimulation to promote walking in paralyzed minipigs. The presentation describes a chronic SCI clinical evaluation program recruiting participants in 2026; efficacy in humans remains under investigation.

Brain–computer interfaces: Implanted BCIs translate neural activity into control signals for external devices, offering potential pathways to improved upper-extremity function. The presentation describes the University of Miami as the second U.S. site for Neuralink's investigational PRIME study and discusses brain-controlled neuromodulation for locomotor recovery.

Rehabilitation and integrated translation: Activity-based training, robotics, vagus nerve stimulation, and individualized neuromodulation may complement neural repair strategies. Multimodal interventions and meaningful functional outcomes remain central research priorities.

TAKE-HOME MESSAGES

- Neuroprotection, circuit repair, and rehabilitation address different phases of injury and recovery.
- Neuromodulation and BCIs are promising tools for restoring function, but their benefits depend on the specific device, population, and evidence stage.
- Translation requires rigorous safety and efficacy testing, with outcomes meaningful to people living with SCI.