Research News

Assistive systems for the healthcare sector

Exoskeleton Aims to Make Daily Life Easier for People with Traumatic Brachial Plexus Injury

The network of nerves in the arm—known as the brachial plexus—transmits motor and sensory signals between the spinal cord and the shoulder, arm and hand. If this network is injured, for example due to a motorcycle accident, the result may be sensory disturbances, muscle weakness or even paralysis. The PLEXO project involves Fraunhofer researchers who are working with partners to develop a myoelectrically controlled exoskeleton designed to assist people with daily tasks. The wearable assistive system is to feature a minimalist, textile-integrated design and be easy and discreet to wear.

A motorcycle accident, serious fall or sports injury can severely stretch or damage the nerve plexus between the neck and arm, in some cases even causing it to tear. It functions like a bundle of electrical wires, transferring the brain's motor commands to the shoulder, arm and hand and sends touch and pain signals back. If these nerves are damaged, the signals are no longer transmitted reliably, resulting in brachial plexus palsy.

This may lead to limited arm mobility or the inability to move the arm at all. Numbness, abnormal sensations and pain are also common. In severe cases of brachial plexus palsy, the entire arm and hand may hang limp at the person's side. This makes even simple everyday tasks a major challenge, such as getting dressed, cooking, washing and carrying things. The treatment is lengthy and laborious. It involves a thorough diagnostic workup, often highly complex microsurgical procedures and intensive physical and occupational therapy. The goal is to restore as much function as possible and prevent long-term complications such as joint stiffness and muscle atrophy. However, even with optimal treatment, it is often not possible to fully restore shoulder mobility.

This is exactly the gap the researchers aim to fill: Assistive devices are available for the hand and elbow, but practical solutions that provide targeted shoulder support for day-to-day use remain scarce. "Our Delphi study, which involved people with the condition and other stakeholders, confirmed a clear need for practical assistive systems that support people with traumatic brachial plexus injury on a daily basis," says Veronika Hofmann, a research scientist at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA. "Those affected often experience reduced independence, pain and emotional distress, and they find it difficult to return to work. Also, they frequently avoid tasks or compensate by putting excessive strain on other parts of the body."

Greater autonomy and improved quality of life

In the context of the PLEXO project (see below), Hofmann and her team are collaborating with industry and research partners to develop a wearable myoelectric exoskeleton. The aim is to make everyday activities such as cooking or washing easier for those affected, thereby helping them gain greater independence and improving their overall quality of life. "Industrial exoskeletons have been available for some time to support employees in areas such as logistics and assembly by helping to reduce the risk of conditions such as herniated discs. But in medical rehabilitation, the goal is to compensate for physical impairments and, in the case of brachial plexus palsy, to restore movement to the arm," says Hofmann. The robotic assistive system is not controlled by voice input or buttons but by sensing muscles, with muscle activity being captured by means of skin-mounted sensors. These electrodes detect electrical activity in the remaining muscles, triggering compact yet powerful integrated motors that assist movement. The exoskeleton also is supposed to have sensors and vibrotactile elements that indicate the arm's current position. "In addition, we plan to integrate functional electrical stimulation (FES), which uses targeted electrical impulses to activate paralyzed or weakened muscles," Hofmann explains.

Minimalist actuation concept and textile-integrated electronics

"Daily activities typically involve both hands: One hand handles fine motor control while the other provides stability. It isn't absolutely necessary to fully restore both functions. Restoring the stabilizing function alone can already make a significant difference," Hofmann explains. So instead of trying to support full shoulder mobility, the researchers opted for a minimalist design: After all, many everyday activities are still possible even with a limited range of motion. The aim is to limit all electronic and mechanical components to the absolute essentials so the assistive system can be designed to be as lightweight and comfortable as possible. This enables a slimmer system and makes its controls easier and more intuitive to learn. Components such as electrodes, sensors and cables are to be integrated into functional textile (Fraunhofer ISC) to make the exoskeleton easier to use on a daily basis. The body-interface components are also essential for the wearing comfort: These are to be custom-made for each patient using 3D printing. The most crucial aspect is ensuring that people actually use the system. The demonstrator is being implemented in collaboration with industrial partners Evomotion GmbH (FES), cirp GmbH (additive manufacturing), and Sensodrive GmbH (actuation technology).

User-centered approach

In developing the exoskeleton, the project partners are placing great emphasis on ensuring that users can put on the textile system independently and operate it intuitively. To achieve strong user acceptance, people with brachial plexus injury are regularly invited to workshops and being closely involved in developing an initial demonstrator. One example was the Plexus Day, which took place at the IPA institute in Stuttgart on 15 June 2026. Participants from across Germany were able to learn about the research project and provide valuable feedback on studying this type of assistive system.

The newly established Plexus Community provides opportunities for ongoing peer exchange, such as regular online meetups. Participants themselves describe these as extremely valuable. Feedback on the planned assistive system from those affected has been consistently positive. A planned end-of-project evaluation by Charité Berlin and Unfallkrankenhaus Berlin is

expected to provide insights into the effectiveness of this innovative approach. "Since the long-term goal is to transfer the prototype into a medical device, we're involving a broad group of experts in our research, including specialists in neurology, neurosurgery, orthopedics, physical therapy, occupational therapy, and nursing," says Hofmann, emphasizing the interdisciplinary approach of the PLEXO project. The goal is to develop an assistive system that not only works from a technical standpoint but can also be operated independently and provides effective daily relief for people with brachial plexus injury.

The PLEXO project

Project funded by:
German Federal Ministry of Research, Technology and Space (BMFTR)

Project launch:
June 1, 2026

Term:
Three years

Project partners:
- Evomotion GmbH
- cirp GmbH
- Sensodrive GmbH
- Charité Berlin / BG Klinikum Unfallkrankenhaus Berlin
- Fraunhofer IPA
- Fraunhofer ISC

Fig. 1 People with brachial plexus injury are regularly invited to workshops and closely involved in developing an initial demonstrator. © Fraunhofer IPA

Fig. 2 Fraunhofer IPA research scientist Veronika Hofmann presents a range of exoskeleton demonstrators featuring different mechanical designs. © Fraunhofer IPA

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