What is the role of functional electrical stimulation in spinal cord injury? Beyond recovery, towards enabling physical activity

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At the end of a full day dedicated to physical activity after spinal cord injury, a simple yet unsettling question was raised: "*What is the point of using functional electrical stimulation (FES) if it does not lead to long-term motor recovery?*"

This question emerged during the colloquium entitled *« Activité physique après lésion médullaire » (54th Entretiens de Médecine Physique et de Réadaptation, Montpellier, March 2026)*, coordonated by Thierry Albert, Julien Metrot, Anthony Gélis and Brigitte Perrouin-Verbe in collaboration with the Association Francophone Internationale des Groupes d'Animation de la Paraplégie (AFIGAP). Throughout the meeting, a consistent message emerged: **physical activity is a central determinant of health, function, and participation after spinal cord injury (SCI)**[1, 2]. From neurophysiological adaptations after SCI to cardiometabolic risk reduction and psychosocial benefits [2, 3, 4], the importance of an active lifestyle was repeatedly emphasized. Within this framework, new technologies—including FES—were presented as enablers of physical activity. Yet, this raises a persistent ambiguity: are these technologies intended to restore function, or to enable physical activity [5, 6]?

The functional and therapeutic benefits of FES are well established [5]. When applied during functional tasks, FES provides an immediate orthotic effect, enabling movements such as cycling, stepping, or grasping that might otherwise be impossible or less efficient [5, 6]. This capacity to generate active movement is particularly relevant in individuals with severe motor impairments, from whom opportunities to engage in exercise may be limited. Importantly, FES has demonstrated beneficial effects on **metabolic and cardiovascular health**, which are major concerns after spinal cord injury. By inducing repeated muscle contractions in large muscle groups below the spinal cord lesion that cannot be voluntarily recruited due to SCI, FES-based interventions—such as FES cycling—can increase energy expenditure, enhance aerobic capacity, and improve glucose metabolism and lipid profiles [3, 4]. In a population characterized by low levels of physical activity and increased cardiometabolic risk, these effects are clinically meaningful. In addition, FES enables a greater **dose and intensity of practice** [6], both of which are key determinants of health and functional outcomes and neuroplasticity. By facilitating task-specific and repetitive activity, FES supports engagement in exercise programs that would otherwise not be feasible. From this perspective, FES acts as a powerful tool to bridge the gap between motor impairment and access to physical activity [5, 6].

Despite these benefits, several limitations restrict physical activity among persons with SCI [7, 8], as well as the widespread and sustained use of FES to promote active behaviours in clinical practice and daily life. First, **technical and economic constraints** remain significant barriers to the widespread adoption/use implementation of FES [6, 9]. Devices are often costly, require maintenance, and may not be easily accessible outside specialized rehabilitation settings. Their use frequently depends on assistance from a trained third party, limiting autonomy and long-term adherence [9]. Reconsidering the role of FES requires a shift from a recovery-centred model to a **participation-oriented approach**, in which enabling physical activity becomes the primary objective [7, 8, 9]. Among the various emerging technologies in neurorehabilitation, **FES is arguably one of the most mature solutions for transfer to real-world, community-based use**. Unlike many robotic or laboratory-based systems, certain FES applications—such as mobile FES-assisted cycling devices (e.g., BerkelBike-type systems)—already allow for **outdoor use and integration into daily life** [6, 9]. This capacity to extend beyond the clinical setting and support activity in ecological environments represents a critical advantage for promoting long-term engagement in physical activity. However, technology alone is not sufficient. The transition from hospital-based interventions to community participation relies on a **coordinated, interdisciplinary approach**, involving physicians, physiotherapists, and adapted physical activity professionals [7, 8]. Physiotherapists play a key role in maintaining functional capacities and ensuring continuity of practice, while adapted physical activity specialists support long-term engagement and lifestyle change, within a framework of medical supervision. Finally, the use of FES should be guided by **clear, individualized goals** aligned with patients' priorities, personal factors, and environmental constraints [10]. Defining specific, measurable, achievable, relevant, and time-bound (SMART) objectives—while taking into account financial accessibility and real-life feasibility—is essential to ensure meaningful and sustainable use. Second, issues related to **usability and versatility** persist. Many FES systems are

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designed for specific tasks (e.g., cycling, stepping), with limited transfer across activities, and consequently, limited adaptability to daily life [6]. Third, both **extrinsic and intrinsic factors** influence effectiveness. Extrinsic factors include device setup, parameter tuning, and environmental constraints, while intrinsic factors encompass muscle fatigue, variability in response to stimulation, and individual tolerance, all of which can complicate sustained use [6, 9]. Finally, FES has often been framed within a **rehabilitation paradigm focused on recovery**, rather than as a long-term tool for health, well-being, and energy expenditure, which may limit its use beyond rehabilitation [5, 6].

Ultimately, the challenge is not to choose between recovery and technology, but to combine innovation, interdisciplinary care, and societal change to make physical activity a realistic and sustainable option for all individuals with spinal cord injury. Beyond technological progress, achieving this objective also requires recognizing that access to physical activity after SCI is a shared responsibility – one that is individual, collective, and political. Existing associations, advocacy initiatives, adapted sport infrastructures, standing programs, and community-based exercise opportunities demonstrate that long-term participation depends not only on rehabilitation technologies, but also on the ecosystems that sustain their use in real-world settings. Individuals must be empowered through education and personalized opportunities; healthcare professionals and communities must foster continuity, accessibility, and inclusion; and policymakers must support equitable access to infrastructure, funding, and public health strategies that make active living feasible beyond specialized centers (Figure 1).

From this perspective, the true value of innovation lies not only in restoring movement, but also in creating the societal conditions that enable people with SCI to remain active, engaged, and healthy throughout life. There is no one-size-fits-all solution: the diversity of impairments and activity limitations following spinal cord injury calls for individualized, context-sensitive approaches tailored to each person's capacities and ambitions [10].

Competing Interest

The author declare to have no competing interests regarding the content of the editorial

Author contribution

Professor Anthony Gélis and Doctor Sébastien Mateo both made substantial contributions to the conception, intellectual development, drafting, critical revision, and final approval of this editorial. Both authors take full responsibility for the content and integrity of the manuscript and approved its submission for publication.

AI statement

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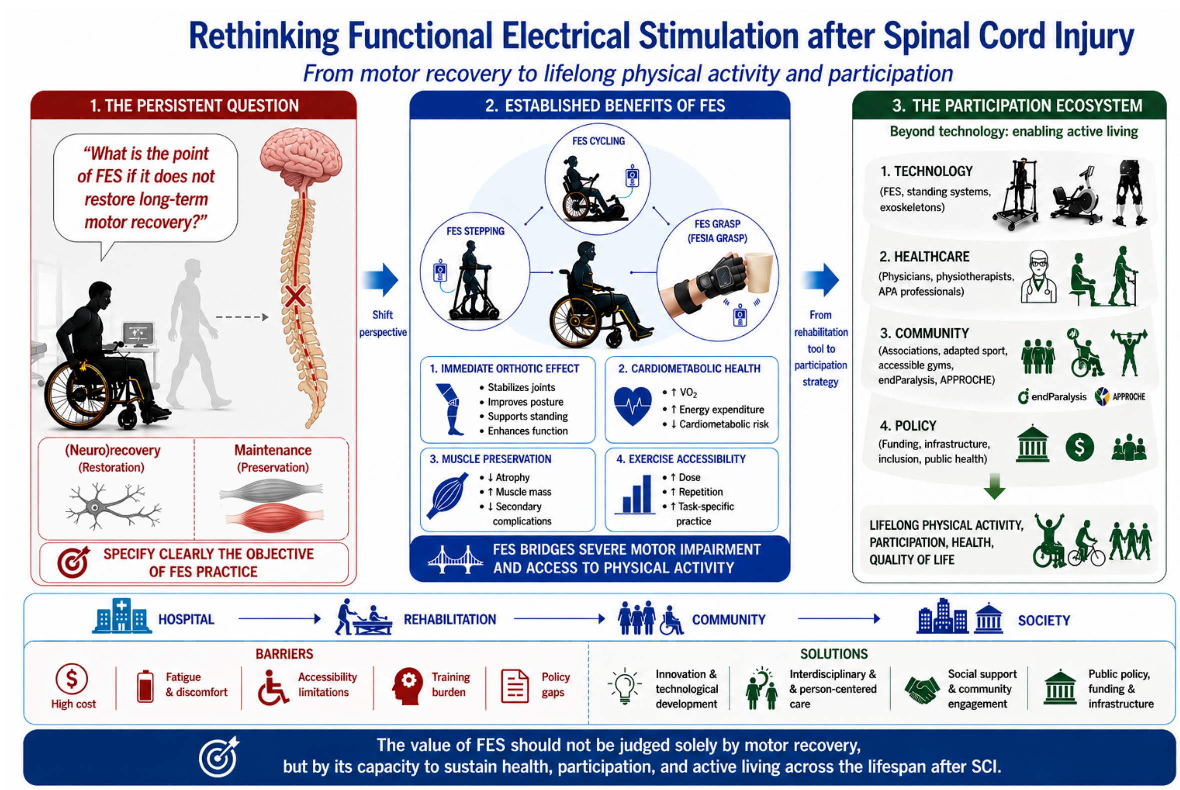

Figure 1 Graphical abstract

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