



The European Coordination Hub for Open Robotics Development



4th Review Meeting – WP3

EXOTrainer

Clinical Evaluation of Gait Training with Exoskeleton in Children with Spinal Muscular Atrophy

Call 1, Exp. 401



Dr. Elena Garcia, Spanish National Research Council (CSIC)

Luxembourg – 2018-02-21

Background

Motivation for the Work Conducted

- **Health & Social need:** *“SMA children’s life expectancy is limited by the lack of walking ability. It is a current need to have a device that allows these children walk effortlessly and so to delay, even avoid related complications”* **Dr. Febrer, MD**, Head of Rehabilitation Children’s Hospital Sant Joan de Déu

Technical Problem Addressed / Challenge Overcome

- **Nature of the problem**, provide a wearable gait exoskeleton for a new group of patients with complexity in symptoms, evolution, restrictions
- **Technical challenge**, self adapt to each patient’s symptoms and to degenerating character

Expertise Relied on

- A first paediatric gait exoskeleton for tetraplegia
- Patented Variable-stiffness actuators
- The best clinical expertise

1 May 2015 / 31 January 2017

Participation in Experiment Booster? YES



Solution Developed

EXOTrainer builds over available technology and addresses a new target group and different diseases

Starting Point

- All commercially available gait exoskeletons were indicated for adult paraplegics.
- The only pediatric gait exoskeleton available (ATLAS) was a research prototype by CSIC, indicated for pediatric tetraplegia, but not for NMD.

ATLAS project, 2010-2013 funded by Spanish Ministry for Innovation and Science



Approach Followed / Development Work Conducted

- EXOTrainer was redesigned for the physiological requirements of SMA children:
 - Additional degrees of freedom (5 per leg) for 3D mobility and thoracic control
 - Minimum user height of 95 cm (the average height of a 3-year old child)
 - Make use of compliant joints, to actively control joint impedance to self adapt to user symptoms



Solution Developed

Approach Followed / Development Work Conducted



Requirements and Specifications



New concept



Mechanics and electronics integration



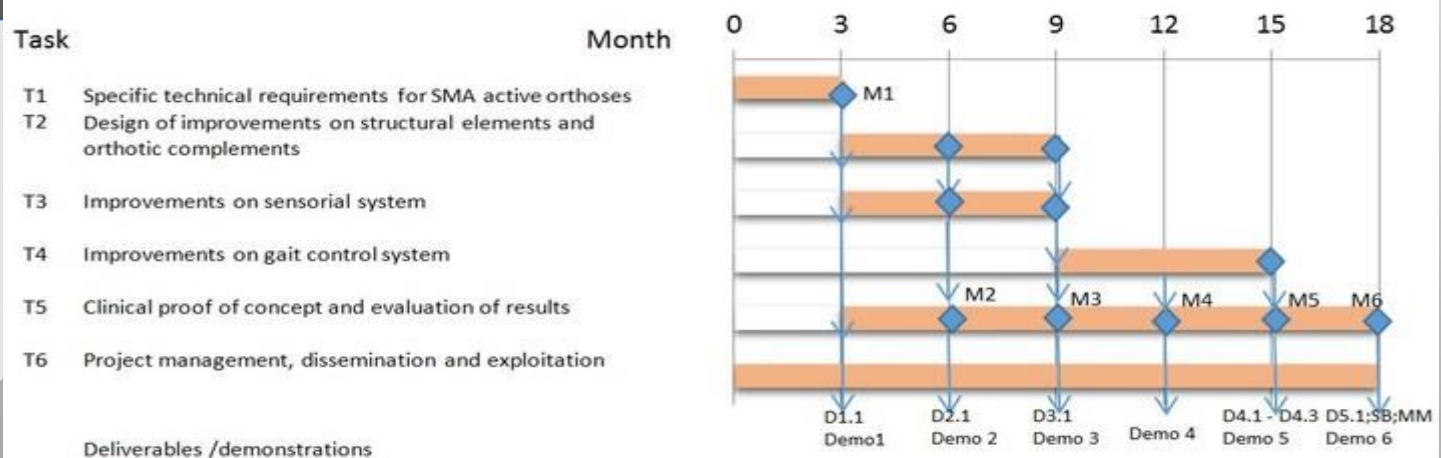
Compliant actuation and motion control development



Functional tests is voluntary children (preclinical)



Clinical evaluation



Solution Developed

Technical Result / End Point

- The project started with a prototype only indicated for SCI.
- The new exoskeleton can be used by more groups of patients, such as those affected by Spinal Muscular Atrophy.



Solution Developed

Technical Result / End Point

TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL7	TRL 8	TRL 9
Basic idea	Concept developed	Experimental development	Laboratory proof of concept	Clinical proof of concept	Device safety demonstrated	Final product validated	CE / FDA Marking	Series production
Basic research		Preclinical research		Late preclinical research	Clinical trials			
Research		Technology Development					Commercialization	

- EXOTrainer departed from TRL 4 and finalized TRL6.
- At present the device has been industrialized and requesting for CE marking. TRL7 to TRL8

Being an Experiment in ECHORD++

Benefit from participation in ECHORD++

Impact on Development Process

- Short-term, very focused, market-driven research which allows realistic testing of prototypes, fast results.
- This research was previously submitted to EU calls without success. This project would not have been realized without the funding from Echord++.



Impact of Work Conducted

ATLAS 2030 PEDIATRIC WEARABLE GAIT EXOSKELETON



Safety frame for postural balance
able to go through doorways 65
cm wide

Ergonomic corset, cuff
and shoes tailor made for
NMD children

Simple size-adjustment
mechanism

Compliant actuators that emulate
the function of natural muscle



BENEFITS

Pediatric exoskeleton for the therapy of neuromuscular diseases since 3 years old

Intensive use offers benefits by improving ROM, delaying the onset of scoliosis, osteoporosis, contractures and other side effects

Gait pattern and driving force are intelligently adapted to each patient's needs

Hands free, provides full mobility in all spatial directions

Positive impact on life quality of children and families.

USER REQUIREMENTS

Max weight 40 kg

Flexos at hip, knee and ankle below 15°

Scoliosis below 20°

Contraindication: Osteoporosis and excessive fragility or skin sensitiveness

Option 8-12 active degrees of freedom

Weight	14 kg
Power	Electric DC
Max speed	0,5 m/s
Battery lifetime	2,5 hours continuous

User height

Adjustable in size	From 1m to 1,5m
Thigh	Size M
Shank	24 cm - 33 cm
Width	23 cm - 32 cm
	24 cm - 35 cm

Being an Experiment in ECHORD++

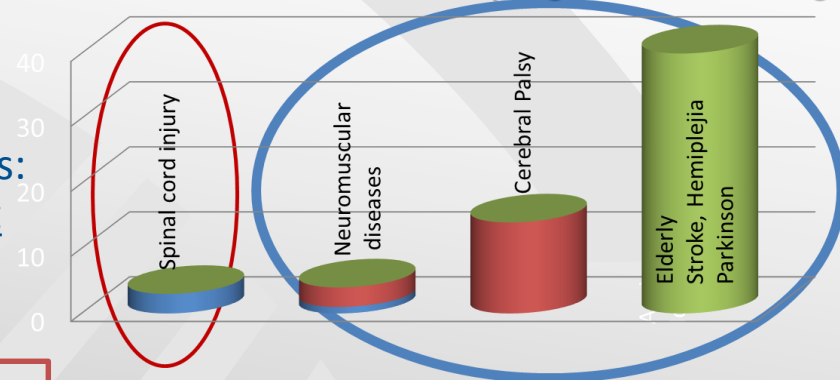
Benefit from participation in ECHORD++

Actionable Insights

- Areas of **possible improvement** for future FSTP in upcoming EC projects: Approach more diseases and target groups

This would have been very difficult to achieve with children that do not preserve their cognitive capabilities. However, after the expertise gained through this project we are now ready to face affections showing non-cognitive capabilities such as Cerebral Palsy.

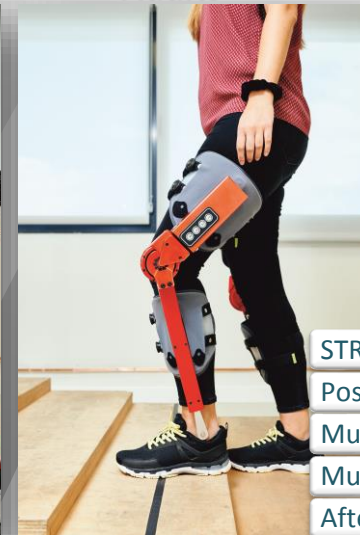
60 M. People can't walk
95% affected by degenerative neurological disorders



Children



Adults



Spinal Muscular Atrophy
Muscular Dystrophy
Cerebral Palsy
Myopathies
Spina Bifida

STROKE / Hemiplegia
PostPolyo
Muscular Dystrophy
Multiple Sclerosis
After surgery rehabilitation

Impact of Work Conducted

What has the support allowed you to achieve

- Increase in technology maturity, test in clinical domain, bring us closer to commercialization

How does the outcome fit with your development strategy

- Exoskeleton already installed at Sant Joan de Deu Childrens Hospital
- Clinical research on impact for ADL

**ATLAS
project**



**E++
EXOTrainer**



**ATLAS 2020
Commercial**



Outlook

